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DATA PROCESSING FOR THE S3 SATELLITES.(U)
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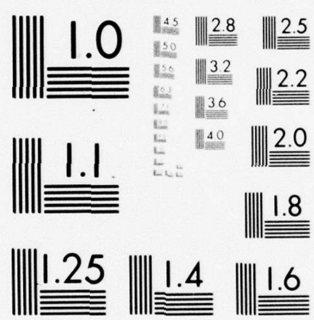

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DATA PROCESSING FOR THE S3 SATELLITES

Dennis E. Delorey

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SCIENTIFIC REPORT NO. 1
30 April 1977

Approved for public release; distribution unlimited

Prepared for

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731

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(19) REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: (18) AFGL-TR-77-0103	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): (6) DATA PROCESSING FOR THE S3 SATELLITES.	5. TYPE OF REPORT & PERIOD COVERED: Scientific-Report No. 1, 1 Feb '76 - 31 Jan '77
	6. PERFORMING ORG. REPORT NUMBER: (14) BC-SDAL-77-3
7. AUTHOR(s): (10) Dennis E. Delorey	8. CONTRACT OR GRANT NUMBER(s): (15) F19628-76-C-0190
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Space Data Analysis Laboratory, Boston College, Chestnut Hill, Ma. 02167	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: N/A
11. CONTROLLING OFFICE NAME AND ADDRESS: Air Force Geophysics Laboratory, Hanscom AFB, Massachusetts 01731, Monitor/Robert E. McInerney/SUA	12. REPORT DATE: (11) 30 April 1977
	13. NUMBER OF PAGES: 92
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (9) Rept. for 1 Feb 76 - 31 Jan 77	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, Distribution Unlimited

(12) 92p.

DDC
JUL 22 1977
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Data Analysis	Data Processing Systems
Data Bases	Satellite Data
Data Processing	S3 satellite data

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Data processing systems were developed and are being implemented for the S3-1, S3-2 and S3-3 satellites. Data flow through the systems is described and the program interfaces defined. Processing requirements for the probes flown aboard the S3-2 vehicle are detailed. Data bases created at all phases of the system are defined. Spacecraft telemetry and operational modes are outlined.

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PREFACE

The author wishes to thank several members of the Space Data Analysis Laboratory of Boston College for their efforts in relation to this task.

Administrative assistance was made available by Mr. Leo F. Power, Jr., the Director of the laboratory.

Analysis, programming and data base creation was accomplished through the efforts of Paul N. Pruneau, Kenneth Dieter, Carolyn Parsons, Roger P. Vancour, Jr., Owen Marr, Neil Grossbard, Edward N. Richards, Brian F. Sullivan, Joyce L. Mendillo, Brian Donovan, Lisa Silva, Geraldine O'Brien and Maria Cunningham.

A special thanks goes to the Contract Monitor, Mr. Robert E. McInerney, for his assistance during the contracting period.

Finally, thanks go to Miss Mary Kelly for typing the document.

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1. INTRODUCTION

The Space Data Analysis Laboratory of Boston College has been contracted by the Analysis and Simulation Branch (SUA) of the Air Force Geophysics Laboratory (AFGL) to develop data processing systems and computer software necessary to reduce and analyze data from satellites S3-1, S3-2 and S3-3.

During this contracting period, the prime effort involved with S3-1 was that of developing geophysical unit data bases for ion density gauges, mass spectrometers and accelerometers which, once created, can be used in the creation of a unified history file.

The data processing system created for vehicle S3-1 was modified for adaptation to S3-2. Overall data flow was defined in a manner analogous to S3-1 but satellite operational procedures required system modifications in several areas. Data processing routines were developed for mass spectrometers, ion density gauges, accelerometers, fluxgate magnetometers and electrostatic analyzers. For certain probes, preprocessing routines were required and these were developed as necessary.

For satellite S3-3, a data processing system was adapted from the S3-2 system. The requirements for this spacecraft consisted of the creation of raw data bases for two AFGL probes and the development of computer files containing magnetic field and ephemeris parameters and attitude determination coefficients.

2.0 SPACECRAFT OPERATIONS AND SATELLITE TELEMETRY

Data was acquired from all three S3 payloads in both real time and tape recorder mode.

For vehicle S3-1, the prime operational mode was that of the tape recorded perigee pass, although selected orbits were designated for real time or full orbit acquisitions. Data was acquired for this vehicle for approximately 2600 orbits.

Operational modes for the S3-2 spacecraft were more complicated than for S3-1 due to the diversity of probes aboard the vehicle. Data acquired from individual orbits was defined as group I (primarily high altitude measurements), group II (mainly used for perigee acquisitions) and shared (from which data was acquired from both group I and group II). The prime data acquired from these operations is from tape recorder playback, although real time data is also taken.

The S3-3 satellite obtains data over a longer orbital period than either of the other vehicles. The prime data is tape recorded aboard the spacecraft and played back over ground receiving stations, although, for selected orbits, a significant amount of real time data is available.

Telemetry transmissions for all three satellites were identical.

The satellite pulse code modulation (PCM) data was telemetered to Satellite Control Facility (SCF)[1] remote tracking stations by Bi-Ø-L modulation of the carrier. The PCM data was transmitted at two data rates. Real time data was telemetered at 16,384 bits per second (bps) while tape recorder playbacks occurred at 131,072 bps. Thus, the tape recorder playback to real time transmittal ratio was 8 to 1. Tape recorded data was transmitted in the reverse order from the real time acquisitions.

The satellite PCM system consisted of a 128 word main frame. Each data word was composed of eight bits and thus each main frame consisted of 1024 bits. Main frame data was readout at a rate of 16 frames per second. Selected words within each main frame were designated for sub-com (SC) readouts. Similarly, selected sub-com words were designed for sub-sub-com (SSC) readouts. Each sub-com and sub-sub-com frame was 16 words in length. Thus, a master frame (one readout from each designation) occurred over 256 main frames (16 seconds).

[1] Satellite Control Facility, Sunnyvale, California

The processor provided an analog-to-digital converter which produced the eight bit digital values for all analog measurements, providing an accuracy of ± .2% ± 1/2 LSB. Included in this figure are all error contributions from the processor input, at sampling time, to the processor output. The voltage range for encoding was 0 to 5.12 VDC.

The PCM processor generated the satellite time word (STW). The STW consisted of 28 bits and allowed for an accumulation through 194 days. The four least significant bits of the STW served as a subcom identifier while least significant bits 5 through 8 identified the sub-subcom frame. The synchronization pattern was contained in main frame words 126, 127 and 128.

3.0 S3 DATA PROCESSING SYSTEMS (DPS)

Data processing systems were developed for the S3 satellites in order to produce geophysical unit data bases for the requisite probes. The data bases contain engineering unit measurements from the individual experiments and each measurement has various ephemeris, magnetic and model parameters associated with it.

In this chapter, the DPS is described in order that the various program interfaces may be understood. The flow of data is depicted from acquisition through to the final data base creations in Figures 1 and 2.

The DPS may be most simply described if it is considered in two phases. In phase I, all files to be input into the individual experiment data processing routines are created. These files consist of the raw experiment data files, magnetic parameter and ephemeris files, atmospheric model files and files containing the coefficients to be used in determining vehicle attitude parameters. In phase II, the individual experiment processing routines are executed and geophysical unit data bases for each spacecraft revolution are created. In addition to these geophysical unit data bases, a unified history file containing reduced data from all probes is to be created. Through history file usage, reduced geophysical unit correlations may be made for all probes which are simultaneously studying the same atmospheric phenomena.

DPS - PHASE I

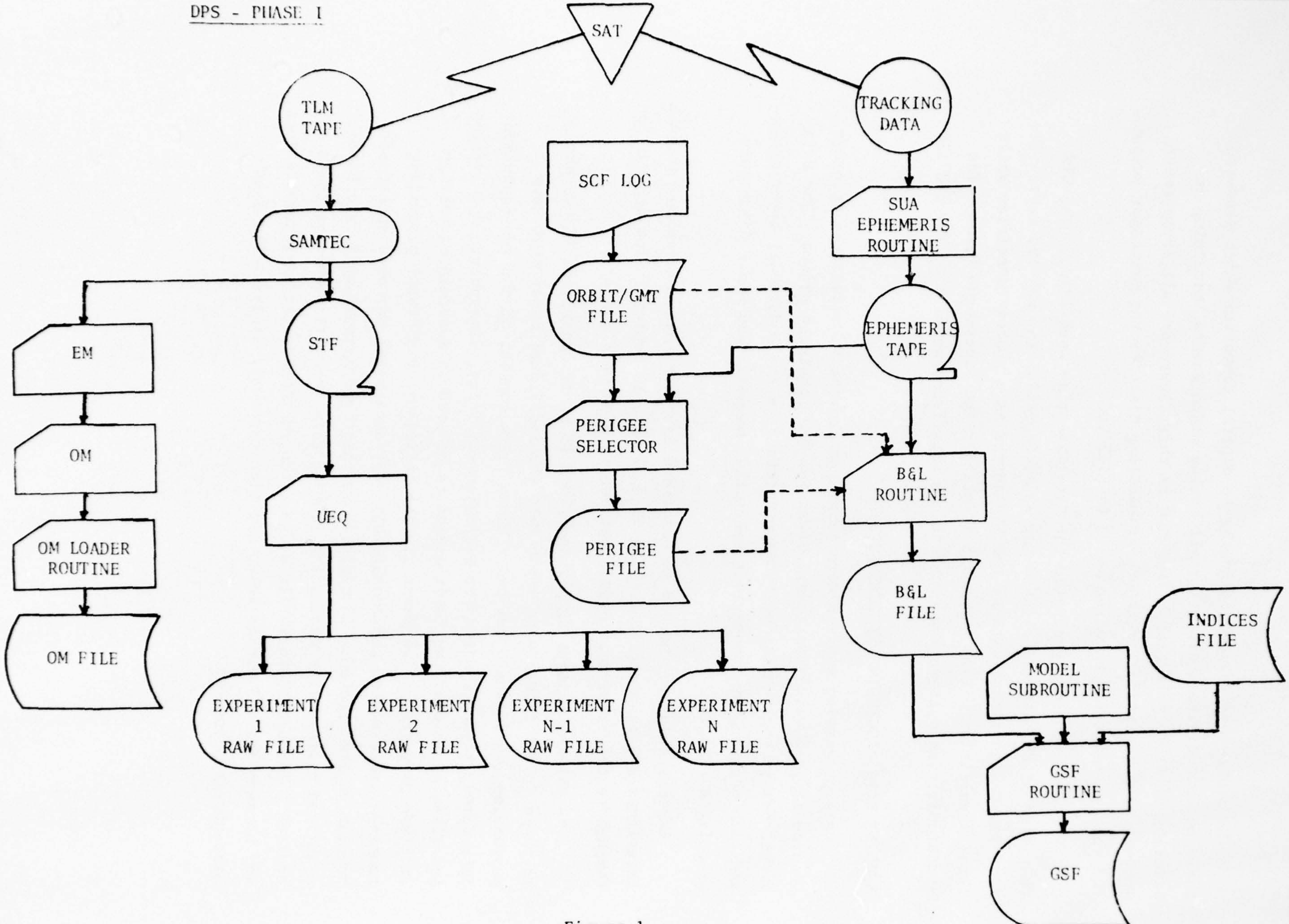


Figure 1

DPS - PHASE II

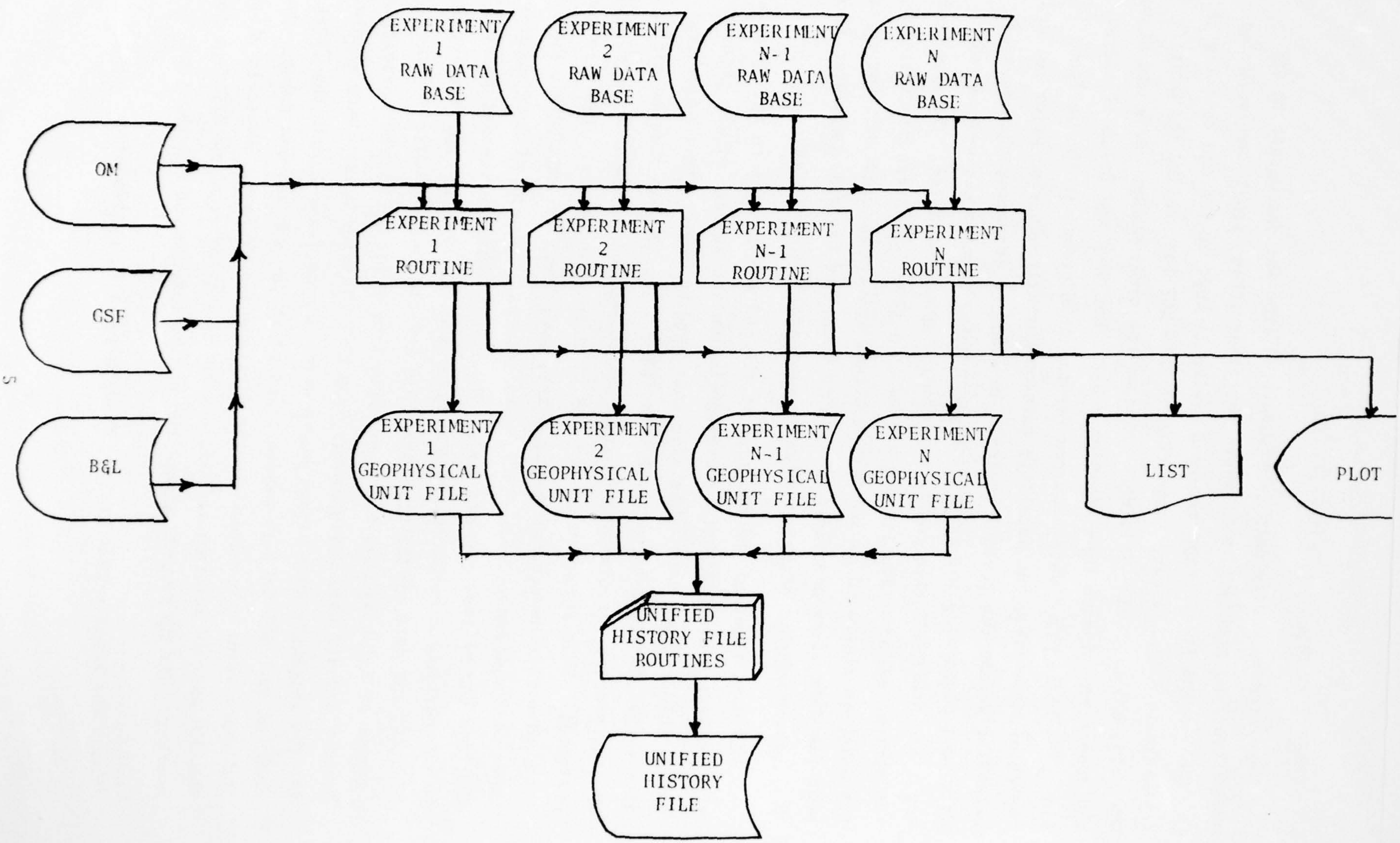


Figure 2

3.1 Phase I of DPS

Satellite telemetry data is transmitted from the spacecraft to SCF remote tracking stations (RTS) where the transmitted signals are recorded on tape. A log of all tape recorded orbits is kept by SCF and this log is available to AFGL. A card image file of this SCF log, called the Orbit/GMT file, was created. This file contains the orbit number, date and start and stop times of each tape recorder orbit. For S3-1 and Group II operations for S3-2, prime data occurred for the AFGL probes in the perigee region of each orbit but satellite turn-on normally occurred prior to, and extending beyond, the perigee region. In order to determine the areas of each pass containing the prime data, a computer routine was written to input the orbit/GMT file and to interrogate ephemeris files. Outputs from the perigee selector routine are stored in a file which can be displayed, but which is also used as input to routines written to construct the experiment raw data files and their associated model and magnetic parameter files. Utilization of this technique aids in minimizing data storage.

PCM data received and recorded at the SCF RTS is sent to the Space and Missile Test Center (SAMTEC)[1] for digitization and storage of the telemetered signal onto 9 track tape. The file name used by SAMTEC for this digital data is the Standard Telemetry Format (STF). The STF was defined and agreed upon at meetings involving AFGL representatives and SAMTEC and spacecraft personnel. File structure of the STF is complex in nature. The file consists of a file descriptor record (FDR), data index records (DIR), data index continuation records (DIC), data records (DR), end of data records (ED) and end of real records (ER). The FDR contains parameters related to the particular orbit on the STF tape such as analog tape number, date of orbit and date of digitization. DIR and DIC records exist for the purpose of defining word locations within DR's for both clock correlation factors and all word designations from the telemetry data. Data records for the telemetry data always begin with sub-com frame 1, but the first data frame on each STF tape is random relative to the sub sub-com frame. Sync and spare words are deleted in the digitization process. Thus, in general, the DIR and DIC information will not be consistent from one STF tape to another. The ED records signal the end of information for the time

[1]Space and Missile Test Center, Vandenberg, AFB, California

correlation and telemetry information for each STF tape. ER is the signal for end of reel operations. One set of data products received at AFGL/SUA for each orbit processed through the SAMTEC digitization system is the STF tape and its associated scan listing. The scan listing contains orbit number, start and stop times of the digitized signal and satellite time words (STW) at which digital dropout occurred.

STF files were created for all three vehicles and the file structure, as defined above, allows for a generalized approach to the digitization process.

UEQ Routine

Upon receipt of the STF and scan listing at SUA, the tape is logged in and the scan sheet filed for easy reference. In order to create user raw data files for each experiment, a computer routine named the unpack/edit/quality check (UEQ) routine was written. This routine uses as input the STF tape and pertinent information from the perigee file, if applicable, such as the prime data area. Perigee file usage is required for S3-1 and S3-2. The UEQ then extracts all necessary information from the FDR, DIR and DIC; unpacks data records according to DIR and DIC specifications; quality checks time code information and sub-com frame numbers; determines occurrences of signal loss; edits out bad data frames: calculates GMT from the STW information; performs averages of several designations as necessary; and creates a raw data file for each experiment in a format which optimizes data storage and retrieval. Permanent storage of output files is, of necessity, accomplished through the use of off-line devices.

Versions of the UEQ routine are unique for each of the three vehicles. The versions are necessitated by the varying processing requirements for the three vehicles, the number of files to be created and the necessity to optimize storage allocations.

Ephemeris

Tracking data is received at AFGL/SUA and this data is input to the SUA ephemeris routines and coverage for each one month period (in 60 second increments) is generated on an output file. Ephemeris parameters for the vehicle include altitude, longitude, geocentric latitude, geodetic latitude, velocity and local time.

The ephemeris file is the basic input to the B&L program.

B&L File

In order to create a magnetic parameter file, called the B&L file, an existing routine was modified for use with these satellites. Versions exist for each spacecraft. The modified routine, called the B&L program, uses as input the monthly ephemeris file and the pertinent parameters from the perigee file (if applicable) to create a B&L file for the prime data of each orbit. One B&L tape is created for each month of the lifetime of the satellites. Among the quantities stored on the B&L file for each orbit are all pertinent ephemeris parameters, magnetic field components, total field, L-Shell and geomagnetic longitude, latitude and local time. Data occurs at 60 second increments for each pass. A modular subroutine was written for the extraction of any or all of the quantities on the B&L file at any time during an orbit.

Indices File

An indices file was created which covered the lifetime of vehicle S3-1. Since the S3-2 and S3-3 lifetimes overlap, one indices file is being created which has application for both vehicles. This file contains the geophysical indices necessary for the interpretation of geophysical unit measurements and for the calculation of model atmospheric parameters. Among the parameters contained on this file are K_p, $F_{10.7}$ CM solar flux, Ap, DST index, calcium plage indices, solar flare indices and solar declination. A modular routine, GPARAM, was written to interrogate this file and to allow for the determination of any of the above quantities for any orbit during the lifetime of the vehicle.

Geophysical Support File

The Geophysical Support File (GSF) contains model atmospheric parameters such as atmospheric neutral mass density, number densities for various constituents such as oxygen and nitrogen and temperature. The main applications for this file are with the S3-1 experiments and the Group II S3-2 probes.

Since GSF computations require knowledge of quantities such as K_p and $F_{10.7}$ CM solar flux, the indices file is a necessary input to this routine (GSFC). In addition, since model values are required only during data-taking periods, the monthly B&L files are also input to GSFC. GSFC utilizes GPARAM and a SUA supplied atmospheric model subroutine (JACCHIA '71) to calculate the Geophysical Support File (GSF) for the prime data period of each tape recorder orbit. Should creation of a different atmospheric model be necessary, the GSFC modification would require only the replacement of the current model subroutine by the newly requested model routine. GSF data is stored on magnetic tape with one tape being created for each month of the lifetime of the satellite.

OM

A computer routine named the Estimation Module (EM) is run at SAMTEC in conjunction with the STF creation. The EM produces an output card file of parameters required to determine vehicle attitude. The card file contains coefficients used in a curve fitting attitude determination technique. A modular OM subroutine has been provided which uses the card file as input and determines look angles for any instrument alignment. The OM card file is received by AFGL/SUA as a data product for each orbit along with the STF and its associated scan listing. For each vehicle, OM card files are loaded onto tape with one tape being created for each month of the lifetime.

Summary

File formats for the S3-2 and S3-3 raw data files, the B&L files, the GSF files and the indices file are contained in the appendix.

3.2 Phase II of DPS

This phase of the processing system differs for the S3-1 and S3-2 satellites since the detailed processing requirements and satellite operations differ. No requirements were received for this phase of the DPS for vehicle S3-3.

In this phase of the processing system, raw data files and the OM, B&L and GSF files are input to individual experimental processing routines.

Formats for these files were defined to allow for easy input to the processing routines.

Modular routines are written wherever possible in order to minimize the amount of computer programming required in this phase (and in Phase I) of the system. Through the use of the modular technique, multi-purpose routines are written which can then be utilized in conjunction with several processing requests. The modular routine technique provides a cost effective means of processing data from diverse probes.

Individual processing routines written in this phase of the DPS provide the necessary computations of geophysical units and result in plots, listings and the creation of a data base containing the appropriate measurements along with ephemeris, magnetic field, atmospheric model and vehicle and instrument attitude parameters.

The Unified History File to be created will allow for the correlation of measurements from all probes both with each other and in relation to varying atmospheric parameters such as K_p. The capability was developed for the generation of history displays whereby density (or other geophysical unit) measurements are selected at fixed altitudes and plotted over the lifetime of the vehicle. The unified history file will contain coefficients for polynomial fits to the appropriate geophysical parameters as functions of altitude. Any predefined ephemeris and magnetic parameters will also be retrievable from the file. Through history file creation, data from all probes for the lifetime of a vehicle may be stored on a maximum of one tape per month basis.

4.0 SATELLITE PROBES

The probes flown aboard the S3-1 vehicle were summarized and the associated processing routines described in a previous report (AFGL-TR-76-0121, Delorey).

Processing routines were developed for several S3-2 instruments. The group II instruments are similar to probes flown aboard S3-1 and the processing requirements and associated routines for these probes are outlined. The functional flow of data for these probes is similar for

S3-1 and S3-2 but probe uniqueness and satellite operations require routines tailored for each vehicle. Group I experiments and the associated processing requirements and computer routines are described in detail.

Requirements for the S3-3 spacecraft consist of creating raw data bases for the AFGL Electric Field and Particle Detector experiments. In addition, a vehicle history file which contains various satellite housekeeping parameters was created. File formats for these data bases are contained in the appendix.

4.1 S3-2 Experiments

The Space Data Analysis Laboratory was contracted to develop the mathematical and computer techniques and associated computer routines necessary to reduce and analyze probe data for the following S3-2 probes; mass spectrometer (MSIV), cold cathode ion density gauge (IDG), piezoelectric accelerometer, electrostatic analyzer (ESA) and fluxgate magnetometer. Computer routines create outputs consisting of plots and listings of geophysical measurements as functions of GMT and various ephemeris and magnetic parameters. In addition, geophysical unit data bases are created.

ESA and fluxgate magnetometer data was acquired from group I spacecraft operations while the group II operations yielded the MSIV, IDG and piezoelectric accelerometer data.

4.1.1 MSIV Experiment

The MSIV probe flown aboard the S3-2 satellite was very similar to the S3-1 experiment of the same name. The probe was made up of an RF quadrupole mass spectrometer in combination with a velocity mass spectrometer. The probe was designed to provide atmospheric composition and species density measurements at altitudes below 500 km. Species studied were between 1 and 44 amu with both neutral and ion measurements of O, N_2, O_2, NO, N, H, H_e and A_r provided. The operation of this MSIV experiment was synchronized to the PCM encoder and five commandable modes of operation were possible. The prime output from the probe was a 24 bit digital readout. Instrument readouts and associated data rates are summarized below:

24 bit digital spectra	64 pps
RF Monitor	64 pps
Beam (EMR) Monitor	4 pps
Pressure Monitor	8 pps
Ratio (V_R) Monitor	8 pps
DC Monitor	8 pps
Commutator	1 pps
Mode Monitor	1 pps
High Voltage (HV) Monitor	2 pps

The processing of data for this experiment is analagous to the S3-1 processing. As previously mentioned, the probe could be operated in 5 modes. Mode 1 was capable of providing a combination of neutral high (NH) and ion measurements or be operated in an ions only mode. Mode 2 provided a combination of neutral high and neutral retarded measurements. In mode 3, the data set consisted of NH only. Mode 4 and mode 5 were primarily diagnostic.

For all modes, the RF monitor indicated the mass being sampled. The 24 bit digital spectra output contained a range bit and the number of counts measured by the multiplier. A maximum of two output ranges was possible. A one readout lag existed between the RF monitor and the spectra output (the spectra lagged the RF monitor by one readout). The experiment timing cycle was 1 second for modes 1, 2 and 3; 2 seconds for mode 4 and 8 seconds for mode 5. In modes 1, 2 and 3 there were four readouts for each mass, thus producing a peak shape. Several monitors were also included as instrument outputs.

A diagram of the functional flow of data through the MSIV routine is provided in Figure 3.

During this contracting period, the emphasis was placed on mode 1 processing. When in ion/NH mode for these operations, measurements were produced for masses 14, 16, 28, 30 and 32. Ions only mode provided measurements for additional species.

In the mode 1 portion of the MSIV routine, the individual mass peaks are selected and attack angles associated with each peak are computed.

MSIV FUNCTIONAL FLOW

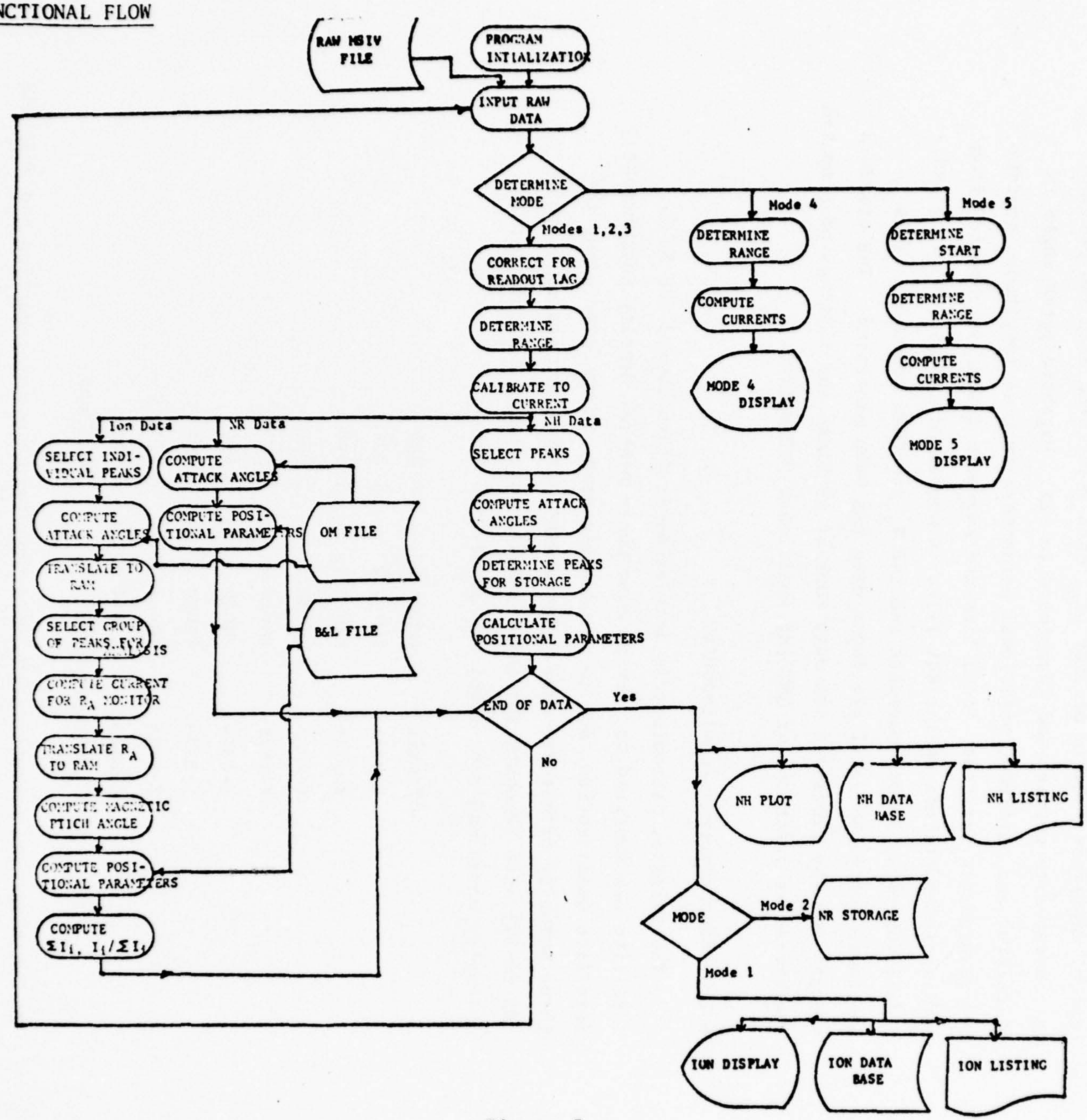


Figure 3

The peaks are to be translated to ram using a function dependent only on attack angle. The four seconds of data closest to ram are scanned and one group of ion readouts is selected for analysis based on criteria involving current amplitude. Ratio monitor (R_A) data associated with ion readouts is converted to current and translated to ram. Magnetic pitch angle is calculated and pertinent positional parameters such as longitude, geodetic and geomagnetic latitude, local time and magnetic field are computed from information contained on the B&L file. A number of ratios involving individual currents, summed currents and the R_A are then computed. This procedure continues until all input data has been processed. The standard outputs for the processed ion data consist of plots and listings of computed quantities as functions of GMT and positional parameters.

4.1.2 Piezoelectric Accelerometer

The triaxial piezoelectric accelerometer flown aboard the S3-2 satellite was designed to provide atmosphere neutral density measurements. Satellite deceleration, due to aerodynamic drag, is measured along the three mutually orthogonal axes. Instrument outputs are analog signals (0V to 5V) with readouts for three sensitivity levels along each axis. The telemetry words and data rates are summarized below:

X-axis	range 3	4 pps
X-axis	range 2	1 pps
X-axis	range 1	1 pps
Y-axis	range 3	1 pps
Y-axis	range 2	1 pps
Y-axis	range 1	1 pps
Z-axis	range 3	1 pps
Z-axis	range 2	1 pps
Z-axis	range 1	1 pps
Temperature		.0625 pps

Mathematical and computer techniques developed for the reduction and analysis of accelerometer data from previous spacecrafts were adapted and modified for use with the S3-2 piezoelectric accelerometer.

Filtering techniques are required in the processing of this accelerometer data. The computer routine filters the signal in order to determine the portion of data due to atmospheric drag. A power spectral analysis of the data revealed the existence of two and sometimes three peaks. A numerical notch filter was designed to remove the extraneous signal. Once filtered, atmospheric neutral density measurements are computed. Plots and listings of the mass density measurements as functions of GMT and other ephemeris, magnetic and model atmosphere parameters are output by the routine.

4.1.3 Cold Cathode Ion Density Gauge (IDG)

The cold cathode ion density gauge flown aboard the S3-2 satellite was designed to provide atmospheric neutral density measurements and spatial and temporal variations. Basically, the output signal from the probe is modulated by the spin of the vehicle with the maximum response occurring when the angle between the instrument and the satellite velocity vector is at a minimum. Gauge current is the direct measurement of the instrument. The current is converted pressure and then, through analysis techniques developed for S3-1, atmospheric neutral density is computed.

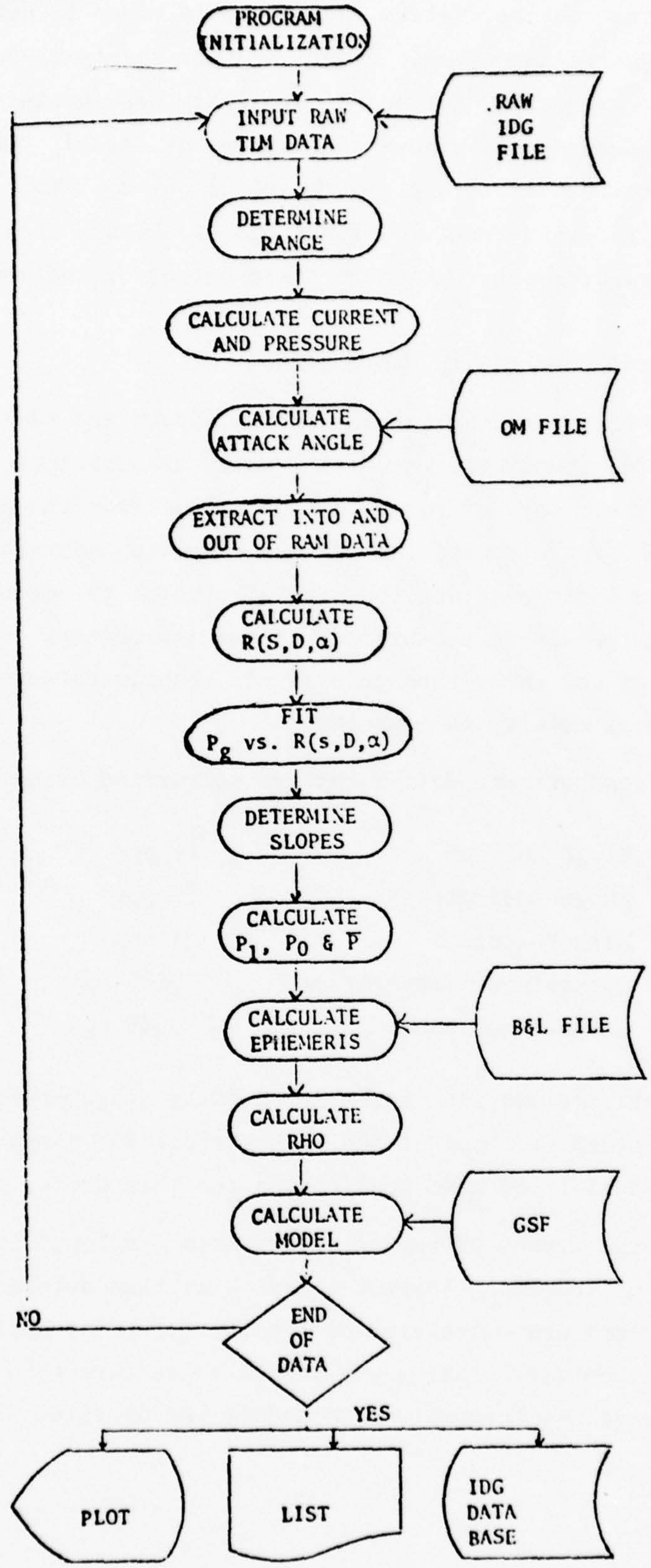
Instrument readouts and data rates are summarized below:

Gauge Current	16 pps
Range Indicator	16 pps
High Voltage	1 pps
Electronics Temperature	.0625 pps
Gauge Temperature	.0625 pps

A functional flow diagram of the ion density gauge processing routine is provided in Figure 4. Most of the mathematical and computer techniques developed for the S3-1 IDG have application for this probe.

Basically, the frames of raw telemetry data are input through the use of a modular input routine. Instrument range is then determined and gauge current and pressure are calculated on a point-for-point basis by means of an interpolation routine. Instrument attack angles are then calculated for all pressure values through the OM module and OM file. The data is then

IDG FUNCTIONAL FLOW



separated into the decreasing and increasing attack angle portions of the ram cycle. The instrument sampling function, R (S,D,α), is then calculated and gauge pressure is fit as a function of the sampling function for the separated portions of the spin cycle. The data fitting is accomplished through a modular polynomial routine. Slopes of the fitted curves are extracted and corrected pressures are calculated for the into and out of ram portions of the satellite rotation and these pressures are then averaged and atmospheric neutral density is computed. All necessary ephemeris parameters are then extracted from the B&L file and atmospheric neutral density is calculated. For comparison with atmospheric model values, a model density is calculated. If the last frame of data has been input, the necessary listing, plots and data base are created and program execution is terminated, otherwise, a new frame of data is input.

4.1.4 Fluxgate Magnetometer

The experiment was designed to measure the 3 components of magnetic field to a resolution of 5 γ. The full scale range for each axis (0V $\rightarrow$ 5V) corresponds to ± 600 γ (.02V corresponds to 4.8 γ).

Each axis has a neutralizing winding current of 10 ma/gauss so that a known biasing field may be applied (to each axis) to keep the magnetometers on scale.

When the voltage level of a fluxgate axis reaches 0.1 or 4.9V the range switch provides current increments of 0.1 ma to the neutralizing coil (0.1 ma corresponds to 1000 γ). These current increments, applied in the proper direction, keep the magnetometer from saturating. There are 128 different current levels available to each axis, corresponding to 1000 γ steps from -64000 γ to +63000 γ. The current being applied to any axis is determined by the range switching coarse and fine outputs for that axis. For the coarse output, there are eight telemetry levels from 0 $\rightarrow$ 5V in steps of 0.71V (seven steps). For fine outputs, there are 16 levels between 0 $\rightarrow$ 5V. The 15 steps are in increments of .33V. The zero current step for coarse is at 2.84V and for fine is at 0V. The current steps for each axis vary from -64 to +63 and the step level may be determined by the expression

$$16N + M$$

where

N,M are integers determined by

$$N \simeq \frac{\text{coarse volts} - 2.84}{.71}$$

$$M = \frac{\text{fine volts}}{.33} \quad .$$

Saturation levels for any range switch axis are determined by a coarse-fine voltage pair of (0.0,0.0) or (5.0,5.0).

Instrument outputs and associated data rates are as follows:

X-magnetometer	32 pps
Y-magnetometer	32 pps
Z-magnetometer	32 pps
X-axis range switch-fine	16 pps
Y-axis range switch-fine	16 pps
Z-axis range switch-fine	16 pps
X-axis range switch-coarse	2 pps
Y-axis range switch-coarse	2 pps
Z-axis range switch-coarse	2 pps
Sensor temperature	1 pps
Electronics temperature	1 pps
Range switch temperature	1 pps

All outputs are analog.

Due to the complications arising from the differing readout rates for the magnetometer, fine and coarse designations for each axis, data for this probe is processed in two phases. The first phase creates a preprocessed file of magnetic field measurements for each axis in units of gammas. The second phase which is in the final development stages will input the preprocessed data and allow for the transformation and comparison of spacecraft measurements in a model magnetic field coordinate system. Absolute values and residuals will be displayed as functions of Greenwich mean time and various ephemeris and geomagnetic parameters.

Within the preprocess routine, the PCM counts are converted to voltage using the linear conversion of 20 millivolts/count. Once the PCM counts are converted to voltages, the x, y and z axis readouts (coarse, fine and magnetometer) are used in the computation of magnetic field in gammas.

For the x axis, integers i and j are computed from the coarse and fine voltages, XC and XF respectively, by the formulas

$$i = \frac{2.843 - xc}{.7063}$$

and

$$j = \frac{.044 - xf}{.3294}$$

These integers are defined in the "nearest integer" sense.

The x-axis step number, s_x, is defined as

$$s_x = 16i + j \quad .$$

The x-axis magnetic field value, x_s, is then computed by

$$x_s = -(b_x)\ (10125) + \left\{243 + .066|s_x|\right\}(x_m - 2.5)$$

where x_m is the x axis magnetometer voltage and b_x is the neutralizing current.

For the y-axis, "nearest integers" k and ℓ are computed from the y-coarse (y_c) and y-fine (y_f) voltages by the relationships

$$k = \frac{2.865 - y_c}{.7097}$$

and

$$\ell = \frac{.029 - y_f}{.3294} \quad .$$

The integers k and ℓ are used in the computation of the step number, s_y, by use of the formula

$$s_y = 16k + \ell$$

and the y-axis magnetic field measurement, y_s, is then computed using the formula

$$y_s = -b_y(10157) + (241.2+.134|s_y|)\ (y_m-2.5)\ .$$

y_m is the y-axis magnetometer readout in voltage and b_y is the neutralizing current.

Similarly, for the z-axis, "nearest integers" m and n, the step number (s_z) and magnetic field measurement, z_s, are computed from the following formulae:

$$m = \frac{2.879-z_c}{.7114}$$

$$n = \frac{.018-z_f}{.3308}$$

$$s_z = 16m + n$$

$$z_s = -b_z(10173) + \{245.4 + .121|s_z|)\}\ (z_m-2.5)$$

where b_z is the z-axis neutralizing current and z_m is the z-axis magnetometer voltage.

The tables of neutralizing current versus step number are included in the appendix.

Measurements obtained in the magnetometer axis system can then be transformed into the principal axis system, yielding components x_p, y_p and z_p, by use of the matrix transformation

$$\begin{pmatrix} x_p \\ y_p \\ z_p \end{pmatrix} = \begin{pmatrix} \cos\eta_2 & -\sin\eta_2\cos\eta_1 & \sin\eta_1\sin\eta_2 \\ \sin\eta_2 & \cos\eta_2\cos\eta_1 & -\sin\eta_1\cos\eta_2 \\ 0 & \sin\eta_1 & \cos\eta_1 \end{pmatrix} \begin{pmatrix} y_s \\ -x_s \\ z_s \end{pmatrix}$$

where η_1 and η_2 are predefined fixed values.

Although formulae are presented in the preceding paragraphs for the computation of integers i, j, k, ℓ, m and n, the resulting step numbers and corresponding magnetic field measurements may result in a discontinuous output. These discontinuities are caused by the fact that the magnetometer reads out twice as frequently as the fine level and 8 times more often than the coarse level. Thus, the step level computed for fine and coarse readouts may actually be associated with preceding magnetometer data. Algorithms were devised for the correction of the fine and coarse readouts and these algorithms were based on providing continuity wherever possible.

The preprocess file format is contained in the appendix.

4.1.5 Electrostatic Analyzer

The electrostatic analyzer performs a 32 channel differential energy analysis of electrons between approximately 1 kev and 16 kev by means of electric field deflection through a parallel plate system. A channeltron electron multiplier detects the selected electrons and they are counted in a 10 bit binary counter with an additional overflow bit indicator. An in-flight calibration source and test pulse generator are included within the instrument to assure the accumulation of one count during each data interval.

A 5 bit up/down counter programs the deflection voltage in a 64 step sequence. The counter steps from 00000_2 to 11111_2 then back to 00000 in 64 steps. The 10 bit data counters, 1 bit overflow indicator and 5 bit up/down control counter are read out as a single 16 bit word at the uniform rate of 64 samples/second. The five bit control counter is incremented every other readout; therefore, a complete 64 step sequence (32 up, 32 down) is completed every 2 seconds.

There are 10 analog monitors which provide outputs used to ascertain proper instrument performance. Monitors 26-11-9 and 26-11-10 will assume different levels for each energy channel.

For the overflow bit, the normal value is 1. An overflow is indicated by a 0 value.

Instrument outputs and associated data rates are as follows:

Description	Rate (pps)
ESA output (16 bit digital)	64
+5v monitor	2
+15v monitor	2
-5v monitor	2
+10v reference monitor	4
+28v monitor	1
Temperature monitor	1
+3kv monitor	8
+3kv input current montor	8
-10kv input current monitor	8
-10kv reference input monitor	8

Data processing for the electrostatic analyzer occurs in two phases. Phase I involves the execution of preprocessing functions and in phase II the data analysis tasks are performed.

In phase I, the 16 bit digital readout is decoded and the energy level and accumulated counts are extracted. The bit order of the 16 bit digital value is depicted below:

$$\text{BIT \#}\ \underbrace{1\ 2\ 3\ 4\ 5\ 6\ 7\ 8\ 9\ 10}_{\text{COUNTS}}\ \underbrace{11}_{\text{OVRFLW}}\ \underbrace{12\ 13\ 14\ 15\ 16}_{\text{ENERGY LEVEL}}$$

Data bit 1 represents the least significant bit (LSB) of the accumulated counts while bit 10 represents the most significant bit (MSB). Bit 11 is the overflow bit. Bit 12 corresponds to the LSB of the energy level and bit 16 represents the MSB.

In phase I, the readouts are ordered into 2 second data frames with each data frame starting at the first of the successive zero level readouts (i.e., - the start of each sweep). Areas where digitization dropout occurs are filled with dummy values and flagged in order to preserve all usable data and also keep the frame structure consistent throughout. In addition to decoding and restructuring data frames, all magnetic and ephemeris parameters required for final processing are merged in the phase I routine.

Standard ESA processing occurs only where the latitude of the acquired data is in excess of 50° in either hemisphere. The latitudinal checks are performed in phase I.

A preprocessed file which is created in phase I is input to the phase II operations. The preprocessed file format is contained in the appendix.

In the final processing phase, the required geophysical unit parameters are computed and sorted into various latitudinal, energy and magnetic pitch angle bins and the final data base is created.

The basic functions performed by the main ESA processor may be summarized as follows: the data from the preprocessed file is input to the routine and the orbit is immediately separated into the sunlight and shaded portions since the data is to be treated separately for the two cases; the data is then sorted into predefined latitude bins with starting, ending and incremental values optional; for each latitude bin, the counts are converted to flux and the flux values are sorted into energy bins of optional width; for each energy level, the average flux and statistical error is computed; flux data is sorted into predefined magnetic pitch angle bins (of optional width) for each energy bin and average flux statistical error and average energy are computed; finally, for each magnetic pitch angle bin, average energy, total energy flux and total flux are computed.

Equations used in the ESA analysis are now included for completeness.

The counts, $M(E_i)$, at energy level E_i are converted to flux, $J(E_i)$, by means of the equation

$$J(E_i) = \frac{M(E_i)/\Delta T}{G\, f_r\, E_i\, \varepsilon(E_i^1)}$$

where

$$\Delta T = \text{time difference between readouts}$$

$$G = 4.68 \times 10^{-5}$$

$$f_r = 0.0419$$

$$E_i^1 = \begin{cases} E_i + 1 \text{ if } E_i > 0.5 \\ 1 \text{ if } E_i \leq 0.5 \end{cases}$$

and

$$\varepsilon(E_i) = 1 - \left[\frac{2}{3 + \frac{6.5}{E_i^1 - 0.5} + \frac{30}{(E_i^1 - 0.5)^3}} \right] .$$

For each energy and magnetic pitch angle bin, p_j, the average flux $(\bar{J}_{p_j}(E_i))$ and statistical error $(\delta\bar{J}_{p_j})$ are defined as follows:

$$\bar{J}_{p_j}(E_i) = \frac{\sum_{1}^{n} J_k(E_i)}{n}$$

and

$$\delta J_{p_j}(E_i) = \begin{cases} \dfrac{\bar{J}_{p_j}(E_i)}{\sqrt{\Sigma M_j(E_i)}} & , \text{ if } \sqrt{\Sigma M_j(E_i)} > o \\[2ex] \dfrac{0.5}{G\ f_r\ E_i\ \Delta T\ \varepsilon(E_i^1)} & , \text{ if } \sqrt{\Sigma M_j(E_i)} = 0 \text{ and } n > o \\[2ex] 0 \text{ , if } n = o & . \end{cases}$$

For each energy bin (with starting and ending indices j_1 and j_2, respectively), the new flux, $\hat{J}(E)$, statistical error, $\delta\hat{J}$, and average energy, $\bar{E}$, are defined as

$$\hat{J}(E) = \frac{\sum_{i=j_1}^{j_2} \bar{J}_{p_j}(E_i)\ \Delta E_i}{\sum_{i=j_1}^{j_2} \Delta E_i}$$

$$\delta\hat{J} = \frac{\sqrt{\sum_{i=j_1}^{j_2} (\delta J_{p_j}(E_i)\ \Delta E_i)^2}}{\sum_{i=j_1}^{j_2} \Delta E_i}$$

$$\bar{E} = \sum_{i=j_1}^{j_2} \frac{E_i}{j_2 - j_1 + 1}$$

where $\Delta E_i = E_i - E_{i-1}$.

For each magnetic pitch angle bin, the average energy (E_{AVE}), total energy flux (J_{ETOT}) and total flux (J_{TOT}) are defined by

$$E_{AVE} = \frac{\sum_{i=o}^{31} \bar{J}_{p_j}(E_i)\ \Delta E_i\ E_i}{\sum_{i=o}^{31} \bar{J}_{p_j}(E_i)\ \Delta E_i} ,$$

$$J_{ETOT} = \sum_{i=o}^{31} \bar{J}_{p_j}(E_i)\ \Delta E_i\ E_i$$

and

$$J_{TOT} = \sum_{i=o}^{31} \bar{J}_{p_j}(E_i)\ \Delta E_i\ .$$

The ESA final data base format is included in the appendix.

APPENDIX A

B&L FILE FORMAT

B&L-Ephemeris Header Record

0.1	Word Count	
0.2	Group Count (1)	
1	Satellite name	A
2	Modified Julian date at start of pass	F
3	Month of year at start of pass	F
4	Day of month at start of pass	F
5	Year (last two digits of 19xx)	F
6,7	Coefficients used in mag. field calculations	A
8	Epoch year of coefficients	F
9	Date coefficients initially updated to	F
10	Start time of pass (GMT) seconds	F
11	End time of pass (GMT) seconds	F
12	Time increment (seconds)	F
13	Indicator for magfield package 0. = INVAR/FIELDG, 1. = SHELLG/FELDG	F
14	Error value for INVAR	F
15	Semi-major axis (km)	F
16	Eccentricity	F
17	Inclination	F
18	Right ascension of ascending mode	F
19	Argument of perigee	F
20	Time of perigee (GMT) sec - neg → no perigee	F
21	Altitude of perigee (km)	F

B&L-Ephemeris Header Record (Cont.)

22	Longitude of perigee (+E)
23	Latitude of Perigee (geodetic)
24	Local time of perigee - seconds
25	Time of apogee (neg $\rightarrow$ no apogee)
26	Altitude of apogee (km)
27	Longitude of apogee (+E)
28	Latitude of apogee (geodetic)
29	Local time of apogee - seconds
30	Start time of vehicle in sun_1 (neg $\rightarrow$ N/A)
31	End time of vehicle in sun_1 (neg $\rightarrow$ N/A)
32	Start time of vehicle in $shade_1$ (neg $\rightarrow$ N/A)
33	End time of vehicle in $shade_1$ (neg $\rightarrow$ N/A)
34	Start time of vehicle in sun_2 (neg $\rightarrow$ N/A)
35	End time of vehicle in sun_2 (neg $\rightarrow$ N/A)
36	Start time of vehicle in $shade_2$ (neg $\rightarrow$ N/A)
37	End time of vehicle in $shade_2$ (neg $\rightarrow$ N/A)
38	Longitude at start of pass
39	Longitude at end of pass
40	Latitude (geodetic) at start of pass
41	Latitude (geodetic) at end of pass
42	Altitude at start of pass
43	Altitude at end of pass
44	Rev no.
45-50	Vacant

B&L - Ephemeris Data Records

0.1	Word count
0.2	Group count
1	Modified Julian Date
2	Calendar month
3	Calendar day
4	Calendar year
5	Hour of day
6	Minute of hour
7	Second of minute
8	GMT in seconds
9	x coordinate of position vector (km)
10	y coordinate of position vector (km)
11	z coordinate of position vector (km)
12	x coordinate of velocity vector (km/sec)
13	y coordinate of velocity vector (km/sec)
14	z coordinate of velocity vector (km/sec)
15	Satellite altitude (km)
16	Distance of satellite from center of earth (km)
17	Satellite velocity (km/sec)
18	Geocentric latitude (±90°)
19	Geodetic latitude (±90°)
20	Satellite longitude (+E)
21	Geomagnetic local time (seconds)
22	Local time (seconds)

23	x coordinate of magnetic field (geodetic) in gamma's
24	y coordinate of magnetic field (geodetic) in gamma's
25	z coordinate of magnetic field (geodetic) in gamma's
26	Geomagnetic coordinate - B
27	Geomagnetic coordinate - L
28	Geomagnetic latitude
29	Geomagnetic longitude
30	Magnetic inclination
31	Magnetic declination
32	Invariant latitude
33	Corrected geomagnetic latitude
34	Corrected geomagnetic longitude
35	Local corrected magnetic time
36	Solar zenith angle
37	Solar longitude
38	Solar right ascension
39	Solar declination
40	Mean anomaly
41-50	Vacant

APPENDIX B

GSF FILE FORMAT

(GSF) Geophysical Support File Header Record

CDC	FORMAT	DESCRIPTION
0.1	I	Word count
0.2	I	Group count
1	A	Satellite name
2	F	Modified Julian date
3	F	Month of year at start of pass
4	F	Day of month at start of pass
5	F	Year of month at start of pass
6	F	Time at start of pass-GMT (Sec)
7	F	Time at end of pass-GMT (Sec)
8	F	Time increment
9	F	Semi Major axis at start of pass
10	F	Eccentricity at start of pass
11	F	Inclination at start of pass
12	F	Right ascension of ascending node
13	F	Argument of perigee
14	F	Time of perigee-GMT Sec (neg → N/A)
15	F	Altitude of perigee (km)
16	F	Longitude of perigee (+E)
17	F	Latitude (geodetic) of perigee
18	F	Local time of perigee (Sec)
19	F	Time of apogee-GMT Sec (neg → N/A)
20	F	Altitude of apogee (km)

(GSF) Geophysical Support File Header Record (Cont.)

CDC	FORMAT	DESCRIPTION
21	F	Longitude of apogee (+E)
22	F	Latitude of apogee (geodetic)
23	F	Local time of apogee (sec)
24	F	Start time of vehicle in sun_1 (neg $\rightarrow$ N/A)
25	F	End time of vehicle in sun_1 (neg $\rightarrow$ N/A)
26	F	*Start time of vehicle in* $shade_1$ *(neg* $\rightarrow$ N/A)
27	F	End time of vehicle in $shade_1$ (neg $\rightarrow$ N/A)
28	F	Start time of vehicle in sun_2 (neg $\rightarrow$ N/A)
29	F	End time of vehicle in sun_2 (neg $\rightarrow$ N/A)
30	F	Start time of vehicle in $shade_2$ (neg $\rightarrow$ N/A)
31	F	End time of vehicle in $shade_2$ (neg $\rightarrow$ N/A)
32	F	F10.7 cm solar flux ($F_{10.7}$)
33	F	F (3 month average)
34	F	K_p value
35	F	A_p value
36	F	Longitude (+E) at start of pass
37	F	Longitude (+E) at end of pass
38	F	Latitude (geodetic) at start of pass
39	F	Latitude (geodetic) at end of pass
40	F	Altitude at start of pass
41	F	Altitude at end of pass
42	F	Rev no. (f)
43-50	F	Vacant

Geophysical Support File Data Records

WORD NO.	FORMAT	DESCRIPTION
0.1	I	Word count
0.2	I	Group count
1	F	GMT (seconds)
2	F	Satellite altitude (km)
3	F	Geocentric latitude (±90°)
4	F	Geodetic latitude (±90°)
5	F	Longitude (+E)
6	F	Local time (seconds)
7	F	Geomagnetic latitude
8	F	Geomagnetic longitude
9	F	Model pressure
10	F	Model temperature (temp at altitude)
11	F	Model density - N_2 (molecular N)
12	F	Model density - O_2 (molecular oxygen)
13	F	Model density - O (atomic oxygen)
14	F	Model density - (gm/cm^3)
15	F	Exospheric temperature
16	F	Model density - H_e (Helium)
17	F	Model density - A_r (Argon)
18	F	Model density - H (Hydrogen)
19-25	Vacant	

APPENDIX C

INDICES FILE FORMAT

APPENDIX C: INDICES FILE FORMAT

WORD NO.	FORMAT	DESCRIPTION
1	F	Month of year
2	F	Day of month
3	F	Year (last 2 digits of 19xx)
4-11	F	K_p values (8)
12	F	$F_{10.7}$ cm solar flux
13	F	Solar declination
14	F	A_p
15	F	Relative sunspot number
16	F	Daily solar index
17	F	Calcium plage
18-41	F	Hourly D_{st} index

APPENDIX D

S3-2 RAW DATA FILE FORMATS

HEADER RECORD FOR DATA FILES OF VEHICLE S3-2

CDC Word	Information	Format
0.1	Word count (30)	I
0.2	Group count (1)	I
1	Vehicle (S3-2)	A
2	Experiment	A
3	Analog tape number	A
4	Orbit number	F
5	Date of orbit xx/xx/xx	A
6	Date STF tape generated (xx/xx/xy)	A
7	Date of creation of user file (xx/xx/xx)	A
8	Start time of data (GMT-SECS)	F
9	Starting altitude (km)	F
10	Code for starting altitude { 1. = increasing; 0. = decreasing }	F
11	Starting latitude	F
12	Code for starting latitude { 1. = increasing; 0. = decreasing }	F
13	End time of data (GMT-seconds)	F
14	Altitude at end of data	F
15	Latitude at end of data	F
16	Julian day (from STF)	I
17 18 19 20	STW1 GMT1 DGMT DSTW } To calculate GMT from STW GMT = [GMT1 + (STW-STW1) DGMT/DSTW]/1000	I
21	Inclination of orbital plane	F
22	Right ascension of ascending node	F
23	Average counts for 21-2-4 (for counts > 3)	F
24	Average counts for 21-4-4 (for counts > 3)	F
25	Mode monitor for 22-7 MSIV	F
26 27 28 29 30	Vacant	

ION DENSITY GAUGE DATA RECORDS (S3-2)

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word Count
2	0.2	1-60		Group Count
3	1	1-60		GMT
4	2-6	1-60	21-2-1	Range_{1-5}
5	7-11	1-60	21-2-1	Range 6-10
6	12-16	1-60	21-2-1	Range 11-15
7	17	1-12	21-2-1	Range_{16}
	18-21	13-60	21-2-2	$\text{Gauge Current}_{1-4}$
8	22-26	1-60	21-2-2	$\text{Gauge Current}_{5-9}$
9	27-31	1-60	21-2-2	$\text{Gauge Current}_{10-14}$
10	32-33	1-24	21-2-2	$\text{Gauge Current}_{15-16}$
	34	25-36	21-2-3	High Voltage
	35-36	37-60	21-4-1	$\text{Gauge Current}_{1-2}$
11	37-41	1-60	21-4-1	$\text{Gauge Current}_{3-7}$
12	42-46	1-60	21-4-1	$\text{Gauge Current}_{8-12}$
13	47-51	1-60	21-4-1	$\text{Gauge Current}_{13-17}$
14	52-56	1-60	21-4-1	$\text{Gauge Current}_{18-22}$
15	57-61	1-60	21-4-1	$\text{Gauge Current}_{23-27}$
16	62-66	1-60	21-4-1	$\text{Gauge Current}_{28-32}$
17	67-71	1-60	21-4-1	$\text{Gauge Current}_{33-37}$
18	72-76	1-60	21-4-1	$\text{Gauge Current}_{38-42}$
19	77-81	1-60	21-4-1	$\text{Gauge Current}_{43-47}$
20	82-86	1-60	21-4-1	$\text{Gauge Current}_{48-52}$
21	87-91	1-60	21-4-1	$\text{Gauge Current}_{53-57}$
22	92-96	1-60	21-4-1	$\text{Gauge Current}_{58-62}$
23	97,98	1-24	21-4-1	$\text{Gauge Current}_{63-64}$
	99-101	25-60	21-4-2	Range_{1-3}
24	102-106	1-60	21-4-2	Range_{4-8}
25	107-111	1-60	21-4-2	Range_{9-13}
26	112,114	1-36	21-4-2	Range_{14-16}
	115,116	37-60	21-4-3	$\text{Filament Emission}_{1-2}$

ION DENSITY GAUGE DATA RECORDS (S3-2) (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
27	117-121	1-60	21-4-3	Filament Emission$_{3-7}$
28	122	1-12	21-4-3	Filament Emission$_{8}$
	123	13-24	21-2-4	Electronic Temperature
	124	25-36	21-2-5	Gauge Temperature
	125	37-48	21-4-4	Electrometer Temperature
	126	49-60	21-4-5	Gauge Temperature
29	127	1-12	21-4-6	Gauge Open/Close

Words 3-29 repeat 17 times within a record (i.e., 18 seconds per record)

ATTITUDE/VEHICLE HISTORY (S3-2)

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word Count
2	0.2	1-60		Group Count
3	1	1-60		GMT
4	2	1-60	A12	Earth Sensor Crossing Time (GMT)
5	3	1-60	A16	Sun Sensor - sun in FDV (GMT)
6	4	1-60	T15	Timer output zero time (GMT)
7	5-8	1-48	A1	P-Axis low_{1-4}
	9	49-60	A2	P-Axis $high_{1}$
8	10-12	1-36	A2	P-Axis $high_{2-4}$
	13-14	37-60	A3	Q-Axis low_{1-2}
9	15-16	1-24	A3	Q-Axis low_{3-4}
	17-19	25-60	A4	Q-Axis $high_{1-3}$
10	20	1-12	A4	Q-Axis $high_{4}$
	21-24	13-60	A5	R-Axis low_{1-4}
11	25-28	1-48	A6	R-Axis $high_{1-4}$
	29	49-60	A7	Magnetometer bias
12	30	1-12	A8	Spin Coil Current
	31	13-24	A17	Sun Sensor - solar aspect angle
	32	25-26	A18	Precession coil REG #1 magnitude
	33	37-48	A19	Precession coil REG #2 magnitude
	34	49-60	A27	Solar Aspect Angle - Fine #1
13	35	1-12	A28	Solar Aspect Angle - Fine #2
	36-39	13-60	T2,T3,T1	Command Word Replica
14	40	1-12	T8	Transmitter Temperature
	41	13-24	T9	Processor cal. low level
	42	25-36	T10	Processor cal. mid level
	43	37-48	T11	Processor cal. high level
	44	49-60	E1	Shunt limiter current
15	45	1-12	E2	Battery current
	46	13-24	E3	Main bus current
	47	25-36	E4	Main bus $voltage_{1}$
	48-49	37-60	E4	Main bus $voltage_{2-3}$

ATTITUDE/VEHICLE HISTORY (S3-2) (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
16	50-54	1-60	E4	Main bus voltage$_{4-8}$
17	55-59	1-60	E4	Main bus voltage$_{9-13}$
18	60-62	1-36	E4	Main bus voltage$_{14-15}$
	63	37-48	E5	Battery Temperature
	64	49-60	E6	Battery state of charge
19	65	1-12	E7	Solar array PNL A804 temp.
	66	13-24	E8	Solar array PNL A805 temp.
	67	25-36	S1	Temperature No. 1
	68	37-48	S2	Temperature No. 2
	69	49-60	S3	Temperature No. 3
20	70	1	E9	Voltage limiter control state enabled
		2	A9	Precession coil timed polarity
		3	A10	Spin coil spin up/down
		4	A11	Precession coil high/low select
		5-6	A13	Earth Sensor polarity
		7	A22	Precession coil on/off
		8	A23	1/4 orbit torqueing selection
		9	A24	1/4 orbit torqueing selection
		10	A25	II & IV positive
		11	A26	I & III positive

Words 3-20 repeat 27 times per record (i.e., 28 seconds per record)

S3-2 EXPERIMENT 226-1→226-7 DATA RECORDS

CDC Word	Data Word	Bits	Desig.	Description
1	1	1-60		Word Count
2	2	1-60		Group Count
3	3	1-60		STW (28 bits-right adjusted)
4	4	1-12	26-7-1	E-Field 12_1 (X1)
	5-8	13-60	26-7-1	E-Field 12_{2-5}
5	9-13	1-60	26-7-1	E-Field 12_{6-10}
6	14-18	1-60	26-7-1	E-Field 12_{11-15}
7	19-23	1-60	26-7-1	E-Field 12_{16-20}
8	24-28	1-60	26-7-1	E-Field 12_{21-25}
9	29-33	1-60	26-7-1	E-Field 12_{26-30}
10	34-38	1-60	26-7-1	E-Field 12_{31-35}
11	39-43	1-60	26-7-1	E-Field 12_{36-40}
12	44-48	1-60	26-7-1	E-Field 12_{41-45}
13	49-53	1-60	26-7-1	E-Field 12_{46-50}
14	54-58	1-60	26-7-1	E-Field 12_{51-55}
15	59-63	1-60	26-7-1	E-Field 12_{56-60}
16	64-67	1-48	26-7-1	E-Field 12_{61-64}
	68	49-60	26-7-2	E-Field 34_1 (X1)
17	69-73	1-60	26-7-2	E-Field 34_{2-6}
18	74-78	1-60	26-7-2	E-Field 34_{7-11}
19	79-83	1-60	26-7-2	E-Field 34_{12-16}
20	84-88	1-60	26-7-2	E-Field 34_{17-21}
21	89-93	1-60	26-7-2	E-Field 34_{22-26}
22	94-98	1-60	26-7-2	E-Field 34_{27-31}
23	99	1-12	26-7-2	E-Field 34_{32}
	100-103	13-60	26-7-3	E-Field 56_{1-4} (X1)
24	104-108	1-60	26-7-3	E-Field 56_{5-9}
25	109-113	1-60	26-7-3	E-Field 56_{10-14}
26	114-118	1-60	26-7-3	E-Field 56_{15-19}
27	119-123	1-60	26-7-3	E-Field 56_{20-24}
28	124-128	1-60	26-7-3	E-Field 56_{25-29}
29	129-131	1-36	26-7-3	E-Field 56_{30-32}
	132-133	37-60	26-7-4	E-Field 12_{1-2} (X10)

S3-2 EXPERIMENT 226-1→226-7 DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
30	134-138	1-60		E-Field 12_{3-7}
31	139-143	1-60		E-Field 12_{8-12}
32	144-148	1-60		E-Field 12_{13-17}
33	149-153	1-60		E-Field 12_{18-22}
34	154-158	1-60	26-7-4	E-Field 12_{23-27} (X10)
35	159-163	1-60	26-7-4	E-Field 12_{28-32}
36	164-168	1-60	26-7-5	E-Field 34_{1-5} (X10)
37	169-173	1-60	26-7-5	E-Field 34_{6-10}
38	174-178	1-60	26-7-5	E-Field 34_{11-15}
39	179-183	1-60	26-7-5	E-Field 34_{16-20}
40	184-188	1-60	26-7-5	E-Field 34_{21-25}
41	189-193	1-60	26-7-5	E-Field 34_{26-30}
42	194-195	1-24	26-7-5	E-Field 34_{31-32}
	196-198	25-60	26-7-6	E-Field 56_{1-3} (X10)
43	199-203	1-60	26-7-6	E-Field 56_{4-8}
44	204-208	1-60	26-7-6	E-Field 56_{9-13}
45	209-213	1-60	26-7-6	E-Field 56_{14-18}
46	214-218	1-60	26-7-6	E-Field 56_{19-23}
47	219-223	1-60	26-7-6	E-Field 56_{24-28}
48	224-227	1-48	26-7-6	E-Field 56_{29-32}
	228	49-60	26-7-19	Length-1
49	229	1-12	26-7-20	Length-2
	230	13-24	26-7-21	Length-3
	231	25-36	26-7-22	Length-4
	232	37-48	26-7-23	Length-5
	233	49-60	26-7-24	Length-6
50	234	1-12	26-7-25	Limit-1
	235	13-24	26-7-26	Limit-2
	236	25-36	26-7-27	Limit-3
	237	37-48	26-7-28	Limit-4
	238	49-60	26-7-29	Limit-5
51	239	1-12	26-7-30	Limit-6
	240-243	13-60	A1	P Axis-Lo_{1-4}

S3-2 EXPERIMENT 226-1→226-7 DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
52	244-247	1-48	A2	P Axis-Hi_{1-4}
	248	49-60	A3	Q Axis-Lo_1
53	249-251	1-36	A3	Q Axis-Lo_{2-4}
	252-253	37-60	A4	Q Axis Hi_{1-2}
54	254-255	1-24	A4	Q Axis Hi_{3-4}
	256-258	25-60	A5	R Axis Lo_{1-3}
55	259	1-12		R Axis Lo_4
	260-263	13-60	A6	R-Axis Hi_{1-4}
56	264	1-12	A7	Magnetometer Bias
56	265	13-24	$ANSC5_4$	
	266	25-36	$ANSC9_2$	
	267	37-48	$ANSC9_{10}$	
	268	49-60		Vacant - Zero Fill

Words 3-56 repeat 8 times per record (i.e., 9 seconds of data per record)

$ANSC5_4$ Words	$ANSC9_2$ Words	$ANSC9_{10}$ Words
26-7-11	21-4-5	26-7-13
26-7-12	21-4-6	26-7-14
24-4-1	34-10	26-7-15
24-4-2	26-7-7	26-7-16
24-4-3	26-7-8	26-7-17
24-4-4	23-2	26-7-18
24-4-5	23-3	
24-4-6	23-4	
24-4-7	24-2-1	
24-4-8	24-2-2	
24-4-9	24-2-3	
24-4-10	24-2-4	
24-5-1	24-2-5	
24-5-2	24-2-6	
24-5-3	26-7-9	
24-5-4	26-7-10	

S3-2 EXPERIMENT 224-1 DATA RECORDS

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word Count (37)
2	0.2	1-60		Group Count ($\leq$13)
3	1	1-60		STW
4	2-3	1-24	24-2-11	Proton Flux $Measurement_{1}$
	4-5	24-48	24-2-11	Proton Flux $Measurement_{2}$
	6	49-60	24-2-11	Proton Flux Measurement
5	7	1-12	24-2-11	Proton Flux $Measurement_{3}$
	8-11	13-60	24-2-11	Proton Flux $Measurement_{4-5}$
6	72-15	1-48	24-2-11	Proton Flux $Measurement_{6-7}$
	16	49-60		
7	17	1-12	24-2-11	Proton Flux $Measurement_{8}$
	18-21	13-60	24-2-11	Proton Flux $Measurement_{9-10}$
8	22-25	1-48	24-2-11	Proton Flux $Measurement_{11-12}$
	26	49-60	24-4-11	200m LLTH
9	27	1-12	24-4-12	200m ULTH
	28	13-24	24-4-13	750 LLTH
	29	25-36	24-4-14	750 ULTH
	30	37-60		
10	32-34	1-36	24-4-15	Proton & Alpha Particle Fluxes Measurement
	35-36	37-60	24-5-21	Digital No. 1_{1}
11	37-38	1-24		
	39-41	25-60	24-5-21	Digital No. 1_{2}
12	42	1-12		
	43-46	13-60	24-5-21	Digital No. 1_{3}
13	47-50	1-48	24-5-21	Digital No. 1_{4}
		49-60		
14	51-54	1-36	24-5-21	Digital No. 1_{5}
	55-56	37-60		
15	57-58	1-24	24-5-21	Digital No. 1_{6}
	59-61	25-60		
16	62	1-12	24-5-21	Digital No. 1_{7}
	63-66	13-60	24-5-21	Digital No. 1_{8}

S3-2 EXPERIMENT 224-1 DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
17	67-70	1-48	24-5-21	Digital No. 1_9
	71	49-60		
18	72-74	1-36	24-5-21	Digital No. 1_{10}
	75-76	37-60		
19	77-78	1-24	24-5-21	Digital No. 1_{11}
	89-81	25-69		
20	82	1-12	24-5-21	Digital No. 1_{12}
	83-86	13-60		
21	87-90	1-48	24-5-21	Digital No. 1_{14}
	91	49-60		
22	92-84	1-36	24-5-21	Digital No. 1_{15}
	95-96	37-60		
23	97-98	1-24	24-5-21	Digital No. 1_{16}
	99-100	25-48	24-5-22	Digital No. 2_1
		49-60		
24	101-102	1-12	24-5-22	Digital No. 2_2
	103-106	13-60	24-5-22	Digital No. 2_{3-4}
25	107-110	1-48	24-5-22	Digital No. 2_{5-6}
		49-60		
26	111-112	1-12	24-5-22	Digital No. 2_7
	113-116	13-60	24-5-22	Digital No. 2_{8-9}
27	117-118	1-24	24-5-22	Digital No. 2_{10}
	119-121	25-60	A1	P-Axis Low_{1-3}
28	122	1-12	A1	P-Axis Low_4
	123-126	13-60	A2	P-Axis High_{1-4}
29	127-130	1-48	A3	Q-Axis Low_{1-4}
	131	49-60	A4	Q-Axis High_1
30	132-134	1-36	A4	Q-Axis High_{2-4}
	135-136	37-60	A5	R-Axis Low_{1-2}
31	137-138	1-24	A5	R-Axis Low_{3-4}
	139-141	25-60	A6	R-Axis High_{1-3}
32	142	1-12	A6	R-Axis High_4
	143	13-24	A7	Magnetometer Bias

S3-2 EXPERIMENT 224-1 DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
	144	25-36	24-2-1	+100 v Det. Mon.
	145	37-48	24-2-2	+15 v Preamp. Mon.
	146	49-60	24-2-3	+5 v Mon.
33	147	1-12	24-2-4	+2.5 v Mon.
	148	13-24	24-2-5	+1.0 v Mon.
	149	25-36	24-2-6	-2.5 v Mon.
	150	37-48	24-4-1	5.0 v Ref.
	151	49-60	24-4-2	2.5 v Ref.
34	152	1-12	24-4-3	0.0 v Ref.
	153	13-24	24-4-4	28 v Mon.
	154	25-36	24-4-5	+15 v Mon.
	155	37-48	24-4-6	+5v Mon.
	156	49-60	24-4-7	-5v Mon.
35	157	1-12	24-4-8	Bias Mon.
	158	13-24	24-4-9	Elec. Temp.
	159	25-36	24-4-10	Detector Temp.
	160	37-48	24-5-1	Magnetometer No. 1
	161	49-60	24-5-2	Magnetometer No. 2
36	162	1-12	24-5-3	Magnetometer No. 3
	163	13-24	24-5-4	Magnetometer No. 4
	164	25-36	24-5-5	Magnetometer No. 5
	165	37-48	24-5-6	Magnetometer No. 6
	166	49-60	24-5-7	Magnetometer No. 7
37	167	1-12	24-5-8	Magnetometer No. 8
	168	13-24	24-5-7	Magnetometer No. 9
	169	25-36	24-5-10	Magnetometer No. 10
	170	37-48	24-5-11	Magnetometer No. 11
	171	49-60	24-5-12	Magnetometer No. 12
38	172	1-12	24-5-13	Magnetometer No. 13
	173	13-24	24-5-14	Magnetometer No. 14
	174	25-36	24-5-15	Magnetometer No. 15
	175	37-48	24-5-16	Magnetometer No. 16
	176	49-60	24-5-17	Magnetometer No. 17

S3-2 EXPERIMENT 224-1 DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
39	177	1-12	24-5-18	Magnetometer No. 18
	178	13-24	24-5-19	Magnetometer No. 19
	179	25-36	24-5-20	Magnetometer No. 20
	180-181	37-60		Vacant

Words (3-39) repeat 12 times within a record (i.e., 13 seconds per record)

S3-2 EXPERIMENT 219-1, -2, -3, -3A DATA RECORDS

CDC Word	Data Word	Bits	Desig.	Information
1	1	1-60		Word Count
2	2	1-60		Group Count
3	3	1-60		Satellite Clock (at SC 0)
4	4	1-12	19-3-13	ES_1
4	5	13-24		ES_2
4	6	25-36		ES_3
4	7	37-48		ES_4
4	8	49-60		ES_5
5,6	9-18	1-60		ES_6 - ES_{15}
7	19	1-12		ES_{16}
7	20	13-24	19-3-14	Range A_1
7	21	25-36		Range A_2
7	22	37-48		Range A_3
7	23	49-60		Range A_4
8-12	24-48	1-60		Range A_5 - A_{29}
13	49-51	1-36		Range A_{30} - A_{32}
13	52	37-48	19-3-15	Range B_1
13	53	49-60		Range B_2
14-19	54-83	1-60		Range B_3 - B_{32}
20-25	84-113	1-60	19-3-17	$R24_1$ - $R24_{30}$
26	114	1-12		$R24_{31}$
26	115	13-24		$R24_{32}$
26	116-118	25-60	19-3-16	$R68_1$ - $R68_3$
27-31	119-143	1-60		$R68_4$ - $R68_{28}$
32	144-147	1-48		$R68_{29}$ - $R68_{32}$
32	148	49-60	19-3-11	$R21_1$
33-35	149-163	1-60		$R21_2$ - $R21_{16}$
36-38	164-178	1-60	19-3-12	$R23_1$ - $R23_{15}$
39	179	1-12		$R23_{16}$
39	180-183	13-60	19-3-9	$R65_1$ - $R65_4$
40-41	184-193	1-60		$R65_5$ - $R65_{14}$

S3-2 EXPERIMENT 219-1, -2, -3, -3A DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Information
42	194-195	1-24		$R65_{15}$ - $R65_{16}$
42	196-198	25-60	19-3-10	$R67_{1}$ - $R67_{3}$
43-44	199-208	1-60		$R67_{4}$ - $R67_{13}$
45	209-211	1-36		$R67_{14}$ - $R67_{16}$
45	212-213	37-60	19-3-5	$I1_{1}$ - $I1_{2}$
46-47	214-223	1-60		$I1_{3}$ - $I1_{12}$
48	224-227	1-48		$I1_{13}$ - $I1_{16}$
48	228	49-60	19-3-6	$I2_{1}$
49-51	229-243	1-60		$I2_{2}$ - $I2_{16}$
52-54	244-258	1-60	19-3-7	$I3_{1}$ - $I3_{15}$
55	259	1-12		$I3_{16}$
55	260-263	13-60	19-3-8	$I4_{1}$ - $I4_{4}$
56-57	264-273	1-60		$I4_{5}$ - $I4_{14}$
58	274-275	1-24		$I4_{15}$ - $I4_{16}$
58	276-278	25-60	19-3-1	$I5_{1}$ - $I5_{3}$
59-60	279-288	1-60		$I5_{4}$ - $I5_{13}$
61	289-291	1-36		$I5_{14}$ - $I5_{16}$
61	292-293	37-60	19-3-2	$I6_{1}$ - $I6_{2}$
62-63	294-303	1-60		$I6_{3}$ - $I6_{12}$
64	304-307	1-48		$I6_{13}$ - $I6_{16}$
64	308	49-60	19-3-3	$I7_{1}$
65-67	309-323	1-60		$I7_{2}$ - $I7_{16}$
68-70	324-338	1-60	19-3-4	$I8_{1}$ - $I8_{15}$
71	339	1-12		$I8_{16}$
71	340-343	13-60	19-3-22	$T12_{1}$ - $T12_{4}$
72	344-347	1-48		$T12_{5}$ - $T12_{8}$
72	348	49-60		ANSSCI

Words 3-72 repeat 6 times within a record (i.e., 7 seconds per record)

S3-2 PIEZOELECTRIC ACCELEROMETER DATA RECORDS

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word Count
2	0.2	1-60		Group Count
3	1	1-60		GMT
4	2-5	1-48	34-1	X2 Signal_{1-4}
	6	49-60	34-2	X3 Signal
5	7	1-12	34-3	X1 Signal
	8	13-24	34-4	Y3 Signal
	9	25-36	34-5	Y2 Signal
	10	37-48	34-6	Y1 Signal
	11	49-60	34-7	Z3 Signal
6	12	1-12	34-8	Z2 Signal
	13	13-24	34-9	Z1 Signal
	14	25-36	34-10	Temperature Monitor
		37-60		Vacant

Words 3-6 repeat 126 times within a record (i.e., 127 seconds per record)

MSIV DATA RECORDS - S3-2

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word Count
2	0.2	1-60		Group Count
3	1	1-60	T4	Satellite Time Word
4	2-5	1-48	22-15	$Spectra_{1-2}$
4		49-60		
5	6-7	1-12	22-15	$Spectra_{3}$
	8-11	13-60	22-15	$Spectra_{4-5}$
6	12-15	1-48	22-15	$Spectra_{6-7}$
6		49-60		
7	16-17	1-12	22-15	$Spectra_{8}$
	18-21	13-60	22-15	$Spectra_{9-10}$
8	22-25	1-48	22-15	$Spectra_{11-12}$
8		49-60		
9	26-27	1-12	22-15	$Spectra_{13}$
	28-31	13-60	22-15	$Spectra_{14-15}$
10	32-35	1-48	22-15	$Spectra_{16-17}$
10		49-60		
11	36-37	1-12	22-15	$Spectra_{18}$
	38-41	13-60	22-15	$Spectra_{19-20}$
12	42-45	1-48	22-15	$Spectra_{21-22}$
12		49-60		
13	46-47	1-12	22-15	$Spectra_{23}$
	48-51	13-60	22-15	$Spectra_{24-25}$
14	52-55	1-48	22-15	$Spectra_{26-27}$
14		49-60		
15	56-59	1-12	22-15	$Spectra_{28}$
	58-61	13-60	22-15	$Spectra_{29-30}$
16	62-65	1-48	22-15	$Spectra_{31-32}$
16		49-60		
17	66-67	1-12	22-15	$Spectra_{33}$
	68-71	13-60	22-15	$Spectra_{34-35}$
18	72-75	1-48	22-15	$Spectra_{36-37}$

MSIV DATA RECORDS - S3-2 (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
18		49-60		
19	76-77	1-12	22-15	$Spectra_{38}$
	78-81	13-60	22-15	$Spectra_{39-40}$
20	82-85	1-48	22-15	$Spectra_{41-42}$
20		49-60		
21	86-87	1-12	22-15	$Spectra_{43}$
	88-91	13-60	22-15	$Spectra_{44-45}$
22	92-95	1-48	22-15	$Spectra_{46-47}$
22		49-60		
23	96-97	1-12	22-15	$Spectra_{48}$
	98-101	13-60	22-15	$Spectra_{49-50}$
24	102-105	1-48	22-15	$Spectra_{51-52}$
24		49-60		
25	106-107	1-12	22-15	$Spectra_{53}$
	108-111	13-60	22-15	$Spectra_{54-55}$
26	112-115	1-48	22-15	$Spectra_{56-57}$
26		49-60		
27	116-117	1-12	22-15	$Spectra_{58}$
	118-121	13-60	22-15	$Spectra_{59-60}$
28	122-125	1-48	22-15	$Spectra_{61-62}$
28		49-60		
29	126-127	1-12	22-15	$Spectra_{63}$
	128-129	13-36	22-15	$Spectra_{64}$
	130-131	37-60	22-1	RF_{1-2}
30	132-136	1-60	22-1	RF_{3-7}
31	137-141	1-60	22-1	RF_{8-12}
32	142-146	1-60	22-1	RF_{13-17}
33	147-151	1-60	22-1	RF_{18-22}
34	152-156	1-60	22-1	RF_{23-27}
35	157-161	1-60	22-1	RF_{28-32}
36	162-166	1-60	22-1	RF_{33-37}
37	167-171	1-60	22-1	RF_{38-42}
38	172-176	1-60	22-1	RF_{43-47}
39	177-181	1-60	22-1	RF_{48-52}

MSIV DATA RECORDS - S3-2 (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
40	182-186	1-60	22-1	RF_{53-57}
41	187-191	1-60	22-1	RF_{58-62}
42	192-193	1-24	22-1	RF_{63-64}
	194-196	25-60	22-4	VR_{1-3}
43	197-201	1-60	22-4	VR_{4-8}
44	202-206	1-60	22-3	$Ratio_{1-5}$
45	207-209	1-36	22-3	$Ratio_{6-8}$
	210-211	37-60	22-5	DC_{1-2}
46	212-216	1-60	22-5	DC_{3-7}
47	217	1-12	22-5	DC_{8}
	218-221	13-60	22-2	$Beam_{1-4}$
48	222	1-12	22-6	Commutator
	223	13-24	22-7	Mode Monitor
	224-225	25-48	22-8	HV $Monitor_{1-2}$
	226	49-60		Vacant

Words 3-48 repeat 11 times within a record (i.e., 11 seconds per record)

S3-2 FLUXGATE DATA RECORDS

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word Count
2	0.2	1-60		Group Count
3	1	1-60		GMT
4	2	1-60	T15	T15
5	3-7	1-60	26-10-1	X-Axis $\text{Magnetometer}_{1-5}$
6	8-12	1-60	26-10-1	X-Axis $\text{Magnetometer}_{6-10}$
7	13-17	1-60	26-10-1	X-Axis $\text{Magnetometer}_{11-15}$
8	18-22	1-60	26-10-1	X-Axis $\text{Magnetometer}_{16-20}$
9	23-27	1-60	26-10-1	X-Axis $\text{Magnetometer}_{21-25}$
10	28-32	1-60	26-10-1	X-Axis $\text{Magnetometer}_{26-30}$
11	33-34	1-24	26-10-1	X-Axis $\text{Magnetometer}_{31-32}$
	35-37	25-60	26-10-2	Y-Axis $\text{Magnetometer}_{1-3}$
12	38-42	1-60	26-10-2	Y-Axis $\text{Magnetometer}_{4-8}$
13	43-47	1-60	26-10-2	Y-Axis $\text{Magnetometer}_{9-13}$
14	48-52	1-60	26-10-2	Y-Axis $\text{Magnetometer}_{14-18}$
15	53-57	1-60	26-10-2	Y-Axis $\text{Magnetometer}_{19-23}$
16	58-62	1-60	26-10-2	Y-Axis $\text{Magnetometer}_{24-28}$
17	63-66	1-48	26-10-2	Y-Axis $\text{Magnetometer}_{29-32}$
	67	49-60	26-10-3	Z-Axis Magnetometer_{1}
18	68-72	1-60	26-10-3	Z-Axis $\text{Magnetometer}_{2-6}$
19	73-77	1-60	26-10-3	Z-Axis $\text{Magnetometer}_{7-11}$
20	78-82	1-60	26-10-3	Z-Axis $\text{Magnetometer}_{12-16}$
21	83-87	1-60	26-10-3	Z-Axis $\text{Magnetometer}_{17-21}$
22	88-92	1-60	26-10-3	Z-Axis $\text{Magnetometer}_{22-26}$
23	93-97	1-60	26-10-3	Z-Axis $\text{Magnetometer}_{27-31}$
24	98	1-12	26-10-3	Z-Axis Magnetometer_{32}
	99-102	13-60	26-10-4	Z-Axis Range Switch Fine_{1-4}
25	103-107	1-60	26-10-4	Z-Axis Range Switch Fine_{5-9}
26	108-112	1-60	26-10-4	Z-Axis Range Switch Fine_{10-14}
27	113-114	1-24	26-10-4	Z-Axis Range Switch Fine_{15-16}
	115-117	25-60	26-10-5	Y-Axis Range Switch Fine_{1-3}
28	118-122	1-60	26-10-5	Y-Axis Range Switch Fine_{4-8}

S3-2 FLUXGATE DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
29	123-127	1-60	26-10-5	Y-Axis Range Switch $Fine_{9-13}$
30	128-130	1-36	26-10-5	Y-Axis Range Switch $Fine_{14-16}$
	131-132	37-60	26-10-6	Z-Axis Range Switch $Fine_{1-2}$
31	133-137	1-60	26-10-6	Z-Axis Range Switch $Fine_{3-7}$
32	138-142	1-60	26-10-6	Z-Axis Range Switch $Fine_{8-12}$
33	143-146	1-48	26-10-6	Z-Axis Range Switch $Fine_{13-16}$
	147	49-60	26-10-7	X-Axis Range Switch $Course_{1}$
34	148	1-12	26-10-7	X-Axis Range Switch $Course_{2}$
	149-150	13-36	26-10-8	Y-Axis Range Switch $Course_{1-2}$
	151-152	37-60	26-10-9	Z-Axis Range Switch $Course_{1-2}$
35	153	1-12	26-10-10	Sensor Temperature
	154	13-24	26-10-11	Electronics Temperature
	155	25-36	26-10-12	Range Switch Temperature
	156-157	37-60	A1	P-Axis Low_{1-2}
36	158-159	1-24	A1	P-Axis Low_{3-4}
	160-162	25-60	A2	P-Axis $High_{1-3}$
37	163	1-12	A2	P-Axis $High_{4}$
	164-167	13-60	A3	Q-Axis Low_{1-4}
38	168-171	1-48	A4	Q-Axis $High_{1-4}$
	172	49-60	A5	R-Axis Low_{1}
39	173-175	1-36	A5	R-Axis Low_{2-4}
	176-177	37-60	A6	R-Axis $High_{1-2}$
40	178-179	1-24	A6	R-Axis $High_{3-4}$
	180	25-36	A7	Magnetometer Bias
	181	37-48	A8	Spin Coil Current
	182	49-60	A18	Precession Coil Reg #1 Magnitude
41	183	1-12	A19	Precession Coil Reg #2 Magnitude
		13	A9	Precession Coil Timed Polarity
		14	A10	Spin Coil Spin Up/Down
		15	A11	Precession Coil High/Low Select
		16	A22	Precession Coil On/Off
		17	A23	1/4 Orbit Torqueing Selection
		18	A24	1/4 Orbit Torqueing Selection
		19-60		Vacant

Words 3-41 repeat 12 times per record. 13 seconds of data per record. (NCHHN=182)

S3-2 ESA DATA RECORDS

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word Count
2	0.2	1-60		Group Count
3	1	1-60		GMT
4	2-3	1-24	26-11-1	+5v $Monitor_{1-2}$
	4-5	25-48	26-11-2	+15v $Monitor_{1-2}$
	6	49-60	26-11-3	-5v $Monitor_{1}$
5	7	1-12	26-11-3	-5v $Monitor_{2}$
	8-11	13-60	26-11-4	+10v Ref. $Monitor_{1-4}$
6	12	1-12	26-11-5	+28v Monitor
	13	13-24	26-11-6	Temperature Monitor
	14-16	25-60	26-11-7	+3kv $Monitor_{1-3}$
7	17-21	1-60	26-11-7	+3kv $Monitor_{4-8}$
8	22-26	1-60	26-11-8	+3kv Input Current $Monitor_{1-5}$
9	27-29	1-36	26-11-8	+3kv Input Current $Monitor_{6-8}$
	30-31	37-60	26-11-9	-10kv Input Current $Monitor_{1-2}$
10	32-36	1-60	26-11-9	-10kv Input Current $Monitor_{3-7}$
11	37	1-12	26-11-9	-10kv Input Current $Monitor_{8}$
	38-41	13-60	26-11-10	-10kv Ref. Input $Monitor_{1-4}$
12	42-45	1-48	26-11-10	-10kv Ref. Input $Monitor_{5-8}$
	46	49-60	26-11-11	Electron $Counter_{1}$
13	47	1-12		
	48-51	13-60	26-11-11	Electron $Counter_{2-3}$
14	52-55	1-48	26-11-11	Electron $Counter_{4-5}$
	56	49-60	26-11-11	Electron $Counter_{6}$
15	57	1-12		
	58-61	13-60	26-11-11	Electron $Counter_{7-8}$
16	62-65	1-48	26-11-11	Electron $Counter_{9-10}$
	66	49-60	26-11-11	Electron $Counter_{11}$
17	67	1-12		
	68-71	13-60	26-11-11	Electron $Counter_{12-13}$
18	72-75	1-48	26-11-11	Electron $Counter_{14-15}$
	76	49-60	26-11-11	Electron $Counter_{16}$
19	77	1-12		

S3-2 ESA DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
	78-81	13-60	26-11-11	Electron Counter$_{17-18}$
20	82-85	1-48	26-11-11	Electron Counter$_{19-20}$
	86	49-60		
21	87	1-12	26-11-11	Electron Counter$_{21}$
	88-91	13-60	26-11-11	Electron Counter$_{22-23}$
22	92-95	1-48	26-11-11	Electron Counter$_{24-25}$
	96	49-60	26-11-11	Electron Counter$_{26}$
23	97	1-12		
	98-101	13-60	26-11-11	Electron Counter$_{27-28}$
24	102-105	1-48	26-11-11	Electron Counter$_{29-30}$
	106	49-60	26-11-11	Electron Counter$_{31}$
25	107	1-12		
	108-111	13-60	26-11-11	Electron Counter$_{32-33}$
26	112-115	1-48	26-11-11	Electron Counter$_{34-35}$
	116	49-60	26-11-11	Electron Counter$_{36}$
27	117	1-12		
	118-121	13-60	26-11-11	Electron Counter$_{37-38}$
28	122-125	1-48	26-11-11	Electron Counter$_{39-40}$
	126	49-60	26-11-11	Electron Counter$_{41}$
29	127	1-12		
	128-131	13-60	26-11-11	Electron Counter$_{42-43}$
30	132-135	1-48	26-11-11	Electron Counter$_{44-45}$
	136	49-60	26-11-11	Electron Counter$_{46}$
31	137	1-12		
	138-141	13-60	26-11-11	Electron Counter$_{47-48}$
32	142-145	1-48	26-11-11	Electron Counter$_{49-50}$
	146	49-60	26-11-11	Electron Counter$_{51}$
33	147	1-12		
	148-151	13-60	26-11-11	Electron Counter$_{52-53}$
34	152-155	1-48	26-11-11	Electron Counter$_{54-55}$
	156	49-60	26-11-11	Electron Counter$_{56}$
35	157	1-12		
	158-161	13-60	26-11-11	Electron Counter$_{57-58}$

S3-2 ESA DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
36	162-165	1-48	26-11-11	Electron Counter$_{59-60}$
	166	49-60	26-11-11	Electron Counter$_{61}$
37	167	1-12		
	168-171	13-60	26-11-11	Electron Counter$_{62-63}$
38	172-173	1-24	26-11-11	Electron Counter$_{64}$
	174-176	25-60		Vacant

Words 3-38 are repeated 13 times within a record (i.e., 14 seconds per record)

APPENDIX E

S3-3 RAW DATA FILE FORMATS

HEADER RECORD FOR DATA FILES OF VEHICLE (S3-3)

CDC Word	Information	Format
0.1	Word Count (30)	I
0.2	Group Count (1)	I
1	Vehicle (S3-3)	R
2	Experiment	R
3	Analog Tape Number	R
4	Orbit Number	F
5	Date of orbit xx/xx/xx	R
6	Date STF tape generated xx/xx/xx	R
7	Date of creation of user file xx/xx/xx	R
8	Start time of data (GMT-SECS)	F
9	Starting altitude (km)	F
10	Code for starting altitude $\begin{cases} 1. = \text{increasing} \\ 0. = \text{decreasing} \end{cases}$	F
11	Starting latitude	F
12	Code for starting latitude $\begin{cases} 1. = \text{increasing} \\ 0. = \text{decreasing} \end{cases}$	F
13	End time of data (GMT-SECS)	F
14	Altitude at end of data	F
15	Latitude at end of data	F
16	Julian Day (from STF)	I
17	STW1 — To calculate GMT from STW	I
18	GMT1 — GMT = [GMT1 + (DTW-STW1)DGMT/DSTW]/1000 .	I
19	DGMT	I
20	DSTW	I
21	Inclination of orbital plane	F
22	Right ascension of ascending node	F
23–30	Vacant	

S3-3 EXPERIMENT 214 DATA RECORDS

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word count (25)
2	0.2	1-60		Group count ($\leq$20)
3	1	1-60		STW
4	2-6	1-60	14-2-8	Digital Data - Proton $Flux_{1-5}$
5	7-11	1-60	14-2-8	Digital Data - Proton $Flux_{6-10}$
6	12-16	1-60	14-2-8	Digital Data - Proton $Flux_{11-15}$
7	17-21	1-60	14-2-8	Digital Data - Proton $Flux_{16-20}$
8	22-26	1-60	14-2-8	Digital Data - Proton $Flux_{21-25}$
9	27-31	1-60	14-2-8	Digital Data - Proton $Flux_{26-30}$
10	32-33	1-24	14-2-8	Digital Data - Proton $Flux_{31-32}$
	34-36	25-60	14-4-7	Digital Data - Proton $Flux_{1-3}$
11	37-41	1-60	14-4-7	Digital Data - Proton $Flux_{4-8}$
12	42-46	1-60	14-4-7	Digital Data - Proton $Flux_{9-13}$
13	47-51	1-60	14-4-7	Digital Data - Proton $Flux_{14-18}$
14	52-56	1-60	14-4-7	Digital Data - Proton $Flux_{19-23}$
15	57-61	1-60	14-4-7	Digital Data - Proton $Flux_{24-28}$
16	62-65	1-48	14-4-7	Digital Data - Proton $Flux_{29-32}$
	66	49-60	14-6-11	Low-level threshold
17	67	1-12	14-6-12	Upper level threshold
	68	13-24	14-6-13	Low level threshold
	69	25-36	14-6-14	Upper level threshold
	70-71	37-60	14-6-15	
18	72-74	1-36	14-6-15	Measures Proton & Alpha Particle Flux
	75-76	37-60	A1	P-axis low_{1-2}
19	77-78	1-24	A1	P-axis low_{3-4}
	79-81	25-60	A2	P-axis $high_{1-3}$
20	82	1-12	A2	P-axis $high_{4}$
	83-86	13-60	A3	Q-axis low_{1-4}
21	87-90	1-48	A4	Q-axis $high_{1-4}$
	91	49-60	A5	R-axis low_{1}
22	92-94	1-36	A5	R-axis low_{2-4}
	95-96	37-60	A6	R-axis $high_{1-2}$

S3-3 EXPERIMENT 214 DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
23	97-98	1-24	A6	R-axis high$_{3-4}$
	99	25-36	A7	Magnetometer bias
	100	37-48	14-2-1	-200 v Det. Mon.
	101	49-60	14-2-2	+10 v Preamp. Mon.
24	102	1-12	14-2-3	Elect. Temp.
	103	13-24	14-2-4	+2.5 v Mon.
	104	25-36	14-2-5	Detector Temp.
	105	37-48	14-2-6	-2.5 v Mon.
	106	49-60	14-4-1	-200 v Mon.
25	107	1-12	14-4-2	+10 v Power Mon.
	108	13-24	14-4-3	Electronics Temp.
	109	25-36	14-4-4	+2.5 v Monitor
	110	37-48	14-4-5	Detector Mon.
	111	49-60	14-4-6	-2.5 v Monitor
26	112	1-12	14-6-1	5.0 v Ref.
	113	1-12	14-6-2	2.5 v Ref.
	114	13-24	14-6-3	0.0 v Ref.
	115	25-36	14-6-4	28 v Mon.
	116	37-48	14-6-5	+15 v Mon.
	117	49-60	14-6-6	+5 v Mon.
27	118	1-12	14-6-7	-5 v Mon.
	119	13-24	14-6-8	Bias Mon.
	120	25-36	14-6-4	Elec. Temp.
	121	37-48	14-6-10	Det. Temp.

Words 3-27 are repeated 19 times within a record, (i.e., 20 seconds per record)

S3-3 EXPERIMENT 215 DATA RECORDS

CDC Word	Data Word	Bits	Desig.	Description
1	0.1	1-60		Word count
2	0.2	1-60		Group count
3	1	1-60		STW
4	2-6	1-60	15-2-1	Current from Sensor #2_{1-5}
5	7-11	1-60	15-2-1	Current from Sensor #2_{6-10}
6	12-16	1-60	15-2-1	Current from Sensor #2_{11-15}
7	17-21	1-60	15-2-1	Current from Sensor #2_{16-20}
8	22-26	1-60	15-2-1	Current from Sensor #2_{21-25}
9	27-31	1-60	15-2-1	Current from Sensor #2_{26-30}
10	32-33	1-24	15-2-1	Current from Sensor #2_{31-32}
	34-36	25-60	15-2-2	Sum and Difference Ratio_{1-3}
11	37-41	1-60	15-2-2	Sum and Difference Ratio_{4-8}
12	42-46	1-60	15-2-2	Sum and Difference Ratio_{9-13}
13	47-51	1-60	15-2-2	Sum and Difference Ratio_{14-18}
14	52-56	1-60	15-2-2	Sum and Difference Ratio_{19-23}
15	57-61	1-60	15-2-2	Sum and Difference Ratio_{24-28}
16	62-65	1-48	15-2-2	Sum and Difference Ratio_{29-32}
	66	49-60	15-2-3	Current from Sensor #4_{1}
17	67-71	1-60	15-2-3	Current from Sensor #4_{2-6}
18	72-76	1-60	15-2-3	Current from Sensor #4_{7-11}
19	77-81	1-60	15-2-3	Current from Sensor #4_{12-16}
20	82-86	1-60	15-2-3	Current from Sensor #4_{17-21}
21	87-91	1-60	15-2-3	Current from Sensor #4_{22-26}
22	92-96	1-60	15-2-3	Current from Sensor #4_{27-31}
23	97	1-12	15-2-3	Current from Sensor #4_{32}
	48-101	13-60	15-2-4	Sum and Difference Ratio_{1-4}
24	102-406	1-60	15-2-4	Sum and Difference Ratio_{5-9}
25	107-111	1-60	15-2-4	Sum and Difference Ratio_{10-14}
26	112-116	1-60	15-2-4	Sum and Difference Ratio_{15-19}
27	117-121	1-60	15-2-4	Sum and Difference Ratio_{20-24}
28	122-126	1-60	15-2-4	Sum and Difference Ratio_{25-29}
29	127-129	1-36	15-2-4	Sum and Difference Ratio_{30-32}
	130-131	37-60	15-2-5	Electrons_{1-2}

S3-3 EXPERIMENT 215 DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
30	132-136	1-60	15-2-5	Electrons_{4-8}
31	137-141	1-60	15-2-5	Electrons_{9-13}
32	142-146	1-60	15-2-5	Electrons_{14-18}
33	147-151	1-60	15-2-5	Electrons_{19-23}
34	152-156	1-60	15-2-5	Electrons_{24-28}
35	157-161	1-60	15-2-5	Electrons_{29-33}
36	162-166	1-60	15-2-5	Electrons_{34-38}
37	167-171	1-60	15-2-5	Electrons_{39-43}
38	172-176	1-60	15-2-5	Electrons_{44-48}
39	177-181	1-60	15-2-5	Electrons_{49-53}
40	182-186	1-60	15-2-5	Electrons_{54-58}
41	187-191	1-60	15-2-5	Electrons_{59-63}
42	192	1-12	15-2-5	Electrons_{64}
	193-196	13-60	15-2-7	Current from Sensor $\#1_{1-4}$
43	197-201	1-60	15-2-7	Current from Sensor $\#1_{5-9}$
44	202-206	1-60	15-2-7	Current from Sensor $\#1_{10-14}$
45	207-211	1-60	15-2-7	Current from Sensor $\#1_{15-19}$
46	212-216	1-60	15-2-7	Current from Sensor $\#1_{20-24}$
47	217-221	1-60	15-2-7	Current from Sensor $\#1_{25-29}$
48	222-224	1-36	15-2-7	Current from Sensor $\#1_{30-32}$
	225-226	37-60	15-2-8	Current from Sensor $\#3_{1-2}$
49	227-231	1-60	15-2-8	Current from Sensor $\#3_{3-7}$
50	232-236	1-60	15-2-8	Current from Sensor $\#3_{8-12}$
51	237-241	1-60	15-2-8	Current from Sensor $\#3_{13-17}$
52	242-246	1-60	15-2-8	Current from Sensor $\#3_{18-22}$
53	247-251	1-60	15-2-8	Current from Sensor $\#3_{23-27}$
54	252-256	1-60	15-2-8	Current from Sensor $\#3_{28-32}$
55	257-261	1-60	15-2-9	Sum and Difference Ratio_{1-5}
56	262-266	1-60	15-2-9	Sum and Difference Ratio_{6-10}
57	267-271	1-60	15-2-9	Sum and Difference Ratio_{11-15}
58	272-276	1-60	15-2-9	Sum and Difference Ratio_{16-20}

S3-3 EXPERIMENT 215 DATA RECORDS (Cont.)

CDC Word	Data Word	Bits	Desig.	Description
59	277-281	1-60	15-2-9	Sum and Difference $Ratio_{21-25}$
60	282-286	1-60	15-2-9	Sum and Difference $Ratio_{26-30}$
61	287-291	1-60	15-2-9	Sum and Difference $Ratio_{31-35}$
62	292-296	1-60	15-2-9	Sum and Difference $Ratio_{36-40}$
63	297-301	1-60	15-2-9	Sum and Difference $Ratio_{41-45}$
64	302-306	1-60	15-2-9	Sum and Difference $Ratio_{46-50}$
65	307-311	1-60	15-2-9	Sum and Difference $Ratio_{51-55}$
66	312-316	1-60	15-2-9	Sum and Difference $Ratio_{56-60}$
67	317-321	1-60	15-2-9	Sum and Difference $Ratio_{61-65}$
68	322-326	1-60	15-2-9	Sum and Difference $Ratio_{66-70}$
69	327-331	1-60	15-2-9	Sum and Difference $Ratio_{71-75}$
70	332-336	1-60	15-2-9	Sum and Difference $Ratio_{76-80}$
71	337-341	1-60	15-2-9	Sum and Difference $Ratio_{81-85}$
72	342-346	1-60	15-2-9	Sum and Difference $Ratio_{86-90}$
73	347-351	1-60	15-2-9	Sum and Difference $Ratio_{91-95}$
74	352-356	1-60	15-2-9	Sum and Difference $Ratio_{96-100}$
75	357-361	1-60	15-2-9	Sum and Difference $Ratio_{101-105}$
76	362-366	1-60	15-2-9	Sum and Difference $Ratio_{106-110}$
77	367-371	1-60	15-2-9	Sum and Difference $Ratio_{111-115}$
78	372-376	1-60	15-2-9	Sum and Difference $Ratio_{116-120}$
79	377-381	1-60	15-2-9	Sum and Difference $Ratio_{121-125}$
80	382-384	1-36	15-2-9	Sum and Difference $Ratio_{126-128}$
	385-386	37-60	15-2-10	Range of $215\text{-}1_{1-2}$
81	387-391	1-60	15-2-10	Range of $215\text{-}1_{3-7}$
82	392-396	1-60	15-2-10	Range of $215\text{-}1_{8-12}$
83	397-401	1-60	15-2-10	Range of $215\text{-}1_{13-17}$
84	402-406	1-60	15-2-10	Range of $215\text{-}1_{18-22}$
85	407-411	1-60	15-2-10	Range of $215\text{-}1_{23-27}$
86	412-416	1-60	15-2-10	Range of $215\text{-}1_{28-32}$
87	417-421	1-60	15-2-10	Range of $215\text{-}1_{33-37}$
88	422-426	1-60	15-2-10	Range of $215\text{-}1_{38-42}$
89	427-431	1-60	15-2-10	Range of $215\text{-}1_{43-47}$

S3-3 EXPERIMENT 215 DATA RECORDS (Cont.)

CDC Word	Data Words	Bits	Desig.	Description
90	432-436	1-60	15-2-10	Range of 215-1_{48-52}
91	437-441	1-60	15-2-10	Range of 215-1_{53-57}
92	442-446	1-60	15-2-10	Range of 215-1_{58-62}
93	447-448	1-24	15-2-10	Range of 215-1_{63-64}
	449	25-36	15-2-11	Temp. of 215-1 package
	450	37-48	15-2-12	E.D. Amplifier Temp.
	451	49-60	15-2-13	Temp. of 215-2 package
94	452	1-12	15-2-14	Monitors Rate Probe

Words 3-94 are repeated 4 times within a record (i.e., 5 seconds per record)

APPENDIX F

FLUXGATE MAGNETOMETER PREPROCESS FILE FORMAT

FLUXGATE PREPROCESS FILE HEADER RECORD

CDC Word	Information	Format
0.1	Word Count (30)	I
0.2	Group Count (1)	I
1	Vehicle (S3-2)	A
2	Experiment	A
3	Analog Tape Number	A
4	Orbit Number	F
5	Date of Orbit xx/xx/xx	A
6	Date STF Tape Generated (xx/xx/xx)	A
7	Date of Creation of User File (xx/xx/xx)	A
8	Start Time of Data (GMT-SECS)	F
7	Starting Altitude (km)	F
10	Code for Starting Altitude { 1. ≈ increasing; 0. ≈ decreasing }	F
11	Starting Latitude	F
12	Code for Starting Latitude { 1. ≈ increasing; 0. ≈ decreasing }	F
13	End Time of Data (GMT-seconds)	F
14	Altitude at End of Data	F
15	Latitude at End of Data	F
16	Julian Day (from STF)	I
17	STW1	I
18	GMT1 — To calculate GMT from STW	I
19	DGMT — GMT = [GMT1 + (STW-STW1) DGMT/DSTW]/1000	I
20	DSTW	I
21	Inclination of Orbital Plane	F
22	Right Ascension of Ascending Node	F
23	Average Counts for 21-2-4 (for counts > 3)	F
24	Average Counts for 21-4-4 (for counts > 3)	F
25	Mode Monitor for 22-7	F
26		
27		
28	Vacant	
29		
30		

FLUXGATE PREPROCESS DATA RECORDS

0.1	Word count (129)		
0.2	Group count (≤ 3)		
1	GMT (GMT at start of data frame)		
2	x-$Field_1$ (γ's)		
3	y-$Field_1$ (γ's)		
4	z-$Field_1$ (γ's)		
5	x-$Field_2$ (γ's)		
6	y-$Field_2$ (γ's)		
7	z-$Field_2$ (γ's)		
⋮			
95	x-$Field_{32}$ (γ's)		
96	y-$Field_{32}$ (γ's)		
97	z-$Field_{32}$ (γ's)		
98	Bits 1-10	$= x_{coarse}$	Integer +3 for x_1 readout
	11-20	$= x_{fine}$	Integer +15 for x_1 readout
	21-30	$= y_{coarse}$	Integer +3 for y_1 readout
	31-40	$= y_{fine}$	Integer +15 for y_1 readout
	41-50	$= z_{coarse}$	Integer +3 for z_1 readout
	51-60	$= z_{fine}$	Integer +15 for z_1 readout
99	Bits 1-10	$= x_{coarse}$	Integer +3 for x_2 readout
	⋮		
129	Bits 51-60	$= z_{fine}$	Integer +15 for z_{32} readout

APPENDIX G

ESA PREPROCESS FILE FORMAT

ESA PREPROCESS FILE HEADER RECORD

0.1	Word Count (56)
0.2	Group Count (1)
1	Satellite Name (bbbbbb S3-2)
2	Experiment Name (bbbbbbb ESA)
3	Orbit Number
4	Month of year at orbit
5	Day of month of orbit
6	Year of orbit (last 2 digits of 19xx)
7	Start time at data base (GMT-SEC)
8	End time of data base (GMT-SEC)
9	Longitude at start (+E)
10	Longitude at end (+E)
11	Latitude (geocentric) at start
12	Latitude (geocentric) at end
13	Magnetic latitude at start
14	Magnetic latitude at end
15	Invariant latitude at start
16	Invariant latitude at end
17	Repeat 7-16 for a maximum of four time intervals
⋮	
46	DGMT from STF
48	DSTW from STF
49	Start time of vehicle in sun_1 (neg. → N/A)
50	End time of vehicle in sun_1 (neg. → N/A)
51	Start time of vehicle in $shade_1$ (neg. → N/A)
52	End time of vehicle in $shade_2$ (neg. → N/A)
53	Start time of vehicle in sun_2 (neg. → N/A)
54	End time of vehicle in sun_2 (neg. → N/A)

ESA PREPROCESS FILE DATA RECORDS

Data is grouped in two second increments

0.1	Word Count (59)
0.2	Group Count ($\leq$ 8)
1	GMT (at first 00_8 level)
2	Altitude (km)
3	Longitude (+E)
4	Geocentric latitude
5	Geomagnetic latitude
6	Invariant latitude
7	Magnetic field (total field)
8	L-Shell
9	Local time (seconds)
10	Magnetic local time
11-15	Magnetic pitch angle (in .4 second increments)

Counts output is stored as follows: The 10 LSB's contain counts; Bit 11 = overflow (0 = normal, 1 = overflow); MSB (Bit 12) = 0 normally, = 1 if dummy filled where dropout occurred.

Word	Bits	
16	1-12	Counts at 00_8 ↑
	13-24	Counts at 00_8 ↑
	25-36	Counts at 01_8 ↑
	37-48	Counts at 01_8 ↑
	49-60	Counts at 02_8 ↑
17	1-12	Counts at 02_8 ↑
	⋮	
28	1-12	Counts at 36_8 ↑
	13-24	Counts at 36_8 ↑
	25-36	Counts at 37_8 ↑
	37-48	Counts at 37_8 ↑
	49-60	Counts at 37_8 ↓
29	1-12	Counts at 37_8 ↓
	13-24	Counts at 36_8 ↓

ESA PREPROCESS FILE DATA RECORDS (Cont.)

Word	Bits	
29 Cont.	25-36	Counts at 36_8 ↓
	37-48	Counts at 35_8 ↓
	49-60	Counts at 35_8 ↓
⋮		
41	1-12	Counts at 01_8 ↓
	13-24	Counts at 00_8 ↓
	25-36	Counts at 00_8 ↓

For monitor storage, MSB=1 if data is dummy filled because of dropout

41	37-48	+5v Monitor_1
	49-60	+5v Monitor_2
42	1-12	+15v Monitor_1
	13-24	+15v Monitor_2
	25-36	-5v Monitor_1
	37-48	-5v Monitor_2
	49-60	+10v Reference Monitor_1
43	1-12	+10v Reference Monitor_2
	13-24	+10v Reference Monitor_3
	25-36	+10v Reference Monitor_4
	37-48	+28v Monitor_1
	49-60	Temperature Monitor_1
44	1-12	+3kv Monitor_1
	13-24	+3kv Monitor_2
	25-60	+3kv Monitor_{3-5}
45	1-12	+3kv Monitor_6
	13-36	+3kv $\text{Monitor}_{7,8}$
	37-48	+3kv Input Current Monitor_1
	49-60	+3kv Input Current Monitor_2
46	1-60	+3kv Input Current Monitor_{3-7}
47	1-12	+3kv Input Current Monitor_8
	13-60	-10kv Input Current Monitor_{1-4}
48	1-48	-10kv Input Current Monitor_{5-8}
	49-60	-10kv Reference Input Monitor_1

ESA PREPROCESS FILE DATA RECORDS (Cont.)

Word	Bits	
49	1-60	-10kv Reference Input Monitor$_{2-6}$
50	1-24	-10kv Reference Input Monitor$_{7-8}$
	25-48	+5v Monitor$_{3-4}$
	49-60	+15v Monitor$_{3}$
51	1-12	+15v Monitor$_{4}$
	13-36	=5v Monitor$_{3-4}$
	37-60	+10v Reference Monitor$_{5-6}$
52	1-24	+10v Reference Monitor$_{7-8}$
	25-36	+28v Monitor$_{2}$
	37-48	Temperature Monitor$_{2}$
	49-60	+3kv Monitor$_{9}$
53	1-60	+3kv Monitor$_{10-14}$
54	1-24	+3kv Monitor$_{15-16}$
	36-60	+3kv Input Current Monitor$_{9-11}$
55	1-60	+3kv Input Current Monitor$_{12-16}$
56	1-60	-10kv Input Current Monitor$_{14-16}$
	37-60	-10kv Reference Input Monitor$_{9-10}$
58	1-60	-10kv Reference Input Monitor$_{11-15}$
59	1-12	-10kv Reference Input Monitor$_{16}$
	13-60	Vacant

APPENDIX H

ESA FINAL DATA BASE FORMAT

ESA DATA BASE HEADER RECORD

0.1	Word Count
0.2	Group Count (1)
1	Satellite Name (bbbbbb S3-2)
2	Experiment Name (bbbbbb ESA)
3	Orbit Number (F)
4	Month of year of orbit (F)
5	Day of year of orbit (F)
6	Year of orbit (last 2 digits of 19xx) (F)
7	Start time of data base (GMT-SEC)
8	End time of data base (GMT-SEC)
9	Longitude at start (+E)
10	Longitude at end (+E)
11	Latitude (geocentric) at start
12	Latitude (geocentric) at end
13	Magnetic latitude at start
14	Magnetic latitude at end
15	Invariant latitude at start
16	Invariant latitude at end
16	Words 7 through 46 repeat for each discrete time interval
47	DGMT from STF
48	DSTW from STF
49	Start time of vehicle in sun$_1$ (neg => N/A)
50	End time of vehicle in sun$_1$ (neg => N/A)
51	Start time of vehicle in shade$_1$ (neg => N/A)
52	End time of vehicle in shade$_1$ (neg => N/A)
53	Start time of vehicle in sun$_2$ (neg => N/A)
54	End time of vehicle in sun$_2$ (neg => N/A)
55	Start time of vehicle in shade$_2$ (neg => N/A)
56	End time of vehicle in shade$_2$ (neg => N/A)
57	Number of pitch angle bins (n)
58	Number of energy bins (m)
59	Increment for latitude bins (in degrees)
60	EBAR$_1$ for energy bin #1 (usually 1-74)

ESA DATA BASE HEADER RECORD (Cont.)

61	$EBAR_2$ for energy bin #2 (usually 5-8)
⋮	$EBAR_{m-1}$ for energy bin #m-1 (usually 25-28)
67	$EBAR_m$ for energy bin #m (usually 29-32)

ESA DATA BASE - DATA RECORDS

0.1	Word Count
0.2	Group Count
1	GMT (at start of latitude increment)
2	Alt (at start of latitude increment)
3	Longitude (at start of latitude increment)
4	Geomagnetic latitude (at start of latitude increment)
5	Invariant latitude (at start of latitude increment)
6	Magnetic field (at start of latitude increment)
7	L-shell (at start of latitude increment)
8	Local time (at start of latitude increment)
9	Magnetic local time (at start of latitude increment)
10	Starting latitude for this interval (geocentric)
11	Ending latitude for this interval (geocentric)
12	Code for sun/shade (0.2 sun, 1 = shade)

Words 13 through end of data frame are broken up into the n pitch angle bins as follows

13 14 15	EAVE JETOT JTOT	for pitch angle bin #1 (usually 0→45°)	Pitch Angle Bin #1 (usually 0°→45°)
16 17	J DJ	for energy bin #1 (usually 1→4)	
18 19	J DJ	for energy bin #2 (usually 5→8)	
20 21	J DJ	for energy bin #3 (9→12)	
⋮			
30 31	J DJ	for energy bin #8 (29→32)	
32 50	EAVE DJ	for pitch angle bin #2 (usually 45→90)	
51 ⋮ 59	EAVE DJ	for pitch angle bin #3 (usually 90→135)	
70 ⋮ 88	EAVE DJ	for pitch angle bin #4 (usually 135→180)	

Words 1→88 repeat for each latitude interval

APPENDIX I

FLUXGATE MAGNETOMETER NEUTRALIZING CURRENT DATA

X-AXIS NEUTRALIZING CURRENT TABLE

Step #	Bias Current (ma)	Step #	Bias Current (ma)	Step #	Bias Current (ma)
64	+6.424	31	3.114	-2	-0.1961
63	6.324	30	3.014	-3	-0.2967
62	6.223	29	2.913	-4	-0.3971
61	6.122	28	2.813	-5	-0.4975
60	6.022	27	2.712	-6	-0.5980
59	5.921	26	2.612	-7	-0.6986
58	5.821	25	2.511	-8	-0.7991
57	5.720	24	2.410	-9	-0.8996
56	5.619	23	2.310	-10	-1.0002
55	5.519	22	2.209	-11	-1.1008
54	5.418	21	2.108	-12	-1.201
53	5.317	20	2.008	-13	-1.302
52	5.217	19	1.907	-14	-1.402
51	5.165	18	1.807	-15	-1.503
50	5.016	+17	1.706	-16	-1.602
49	4.915	+16	+1.607	-17	-1.703
48	4.816	15	1.506	-18	-1.803
47	4.715	14	1.406	-19	-1.904
46	4.615	13	1.305	-20	-2.004
45	4.514	12	1.205	-21	-2.105
44	4.414	11	1.1044	-22	-2.206
43	4.314	10	1.0038	-23	-2.306
42	4.213	9	0.9032	-24	-2.407
41	4.112	8	0.8026	-25	-2.508
+40	+4.011	-7	0.7019	-26	-2.608
39	3.911	6	0.6014	-27	-2.709
38	3.810	5	0.5007	-28	-2.809
37	3.709	4	0.4004	-29	-2.910
36	3.609	3	0.2997	-30	-3.011
35	3.508	+2	+0.1990	-31	-3.111
34	3.408	+1	+0.0980	-32	-3.203
33	3.307	0	+0.0054	-33	-3.304
32	3.215	-1	-0.0952	-34	-3.405

X-AXIS NEUTRALIZING CURRENT TABLE (Cont.)

Step #	Bias Current (ma)
-35	-3.505
-36	-3.606
-37	-3.706
-38	-3.807
-39	-3.908
-40	-4.008
-41	-4.109
-42	-4.210
-43	-4.311
-44	-4.411

Step #	Bias Current (ma)
-45	-4.512
-46	-4.612
-47	-4.713
-48	-4.812
-49	-4.913
-50	-5.014
-51	-5.114
-52	-5.215
-53	-5.315
-54	-5.416

Step #	Bias Current (ma)
-55	-5.517
-56	-5.617
-57	-5.718
-58	-5.819
-59	-5.919
-60	-6.020
-61	-6.120
-62	-6.221
-63	-6.322

Y-AXIS NEUTRALIZING CURRENT TABLE

Step #	Bias Current (ma)	Step #	Bias Current (ma)	Step #	Bias Current (ma)
+64	+6.423	31	3.110	-2	-0.1996
63	6.322	30	3.010	-3	-0.3003
62	6.222	29	2.909	-4	-0.4007
61	6.121	28	2.809	-5	-0.5011
60	6.021	27	2.708	-6	-0.6016
59	5.920	26	2.607	-7	-0.7021
58	5.819	25	2.507	-8	-0.8025
57	5.719	24	2.406	-9	-0.9031
56	5.618	23	2.306	-10	-1.0037
55	5.518	22	2.205	-11	-1.1042
54	5.417	21	2.105	-12	-1.205
53	5.316	20	2.004	-13	-1.305
52	5.616	19	1.904	-14	-1.406
51	5.115	18	1.803	-15	-1.506
50	5.015	17	1.702	-16	-1.606
49	4.914	16	1.603	-17	-1.707
48	4.815	15	1.502	-18	-1.807
47	4.714	14	1.402	-19	-1.908
46	4.613	13	1.301	-20	-2.008
45	4.513	12	1.201	-21	-2.109
44	4.412	+11	+1.1001	-22	-2.210
43	4.312	+10	+0.9995	-23	-2.310
42	4.211	9	0.8988	-24	-2.411
41	4.110	8	0.7984	-25	-2.511
40	4.010	7	0.6977	-26	-2.612
39	3.909	6	0.5972	-27	-2.713
+38	+3.809	5	0.4965	-28	-2.813
+37	+3.709	4	0.3961	-29	-2.914
36	3.608	3	0.2955	-30	-3.014
35	3.508	2	+0.1947	-31	-3.115
34	3.407	+1	+0.0938	-32	-3.211
33	3.306	+0	+0.0020	-33	-3.311
32	3.211	-1	-0.0986	-34	-3.412

Y-AXIS NEUTRALIZING CURRENT TABLE (Cont.)

Step #	Bias Current (ma)	Step #	Bias Current (ma)	Step #	Bias Current (ma)
-35	-3.512	-45	-4.518	-55	-5.523
-36	-3.613	-46	-4.619	-56	-5.624
-37	-3.713	-47	-4.720	-57	-5.725
-38	-3.814	-48	-4.819	-58	-5.825
-39	-3.915	-49	-4.920	-59	-5.926
-40	-4.015	-50	-5.021	-60	-6.026
-41	-4.116	-51	-5.121	-61	-6.127
-42	-4.217	-52	-5.222	-62	-6.227
-43	-4.317	-53	-5.322	-63	-6.328
-44	-4.418	-54	-5.423		

Z-AXIS NEUTRALIZING CURRENT TABLE

Step #	Bias Current (ma)	Step #	Bias Current (ma)	Step #	Bias Current (ma)
+64	+6.416	31	3.106	-2	-0.1947
63	6.315	30	3.005	-3	-0.2953
62	6.214	29	2.904	-4	-0.3959
61	6.114	28	2.804	-5	-0.4965
60	6.013	27	2.703	-6	-0.5970
59	5.912	26	2.602	-7	-0.6976
58	5.812	25	2.5015	-8	-0.7976
57	5.711	24	2.4015	-9	-0.8983
56	5.611	23	2.301	-10	-0.9989
55	5.510	22	2.200	-11	-1.0996
54	5.409	21	2.099	-12	-1.200
53	5.309	20	1.999	-13	-1.301
52	5.208	19	1.898	-14	-1.402
51	5.107	18	1.797	-15	-1.502
50	5.007	17	1.697	-16	-1.600
49	4.906	16	1.599	-17	-1.701
48	4.808	15	1.498	-18	-1.802
47	4.707	14	1.397	-19	-1.902
46	4.607	13	1.2965	-20	-2.003
45	4.506	12	1.1961	-21	-2.104
44	4.405	+11	1.0953	-22	-2.204
43	4.304	+10	+0.9947	-23	-2.305
42	4.204	9	0.8940	-24	-2.405
41	4.103	8	0.7940	-25	-2.506
40	4.003	7	0.6933	-26	-2.607
39	3.902	6	0.5927	-27	-2.707
+38	3.802	5	0.4919	-28	-2.808
+37	+3.701	4	0.3912	-29	-2.909
36	3.600	3	0.2904	-30	-3.009
35	3.500	+2	+0.1896	-31	-3.110
34	3.399	+1	+0.0884	-32	-3.202
33	3.298	+0	+0.0069	-33	-3.303
32	3.206	-1	-0.0935	-34	-3.404

Z-AXIS NEUTRALIZING CURRENT TABLE (Cont.)

Step #	Bias Current (ma)	Step #	Bias Current (ma)	Step #	Bias Current (ma)
-35	-3.504	-45	-4.511	-55	-5.515
-36	-3.605	-46	-4.612	-56	-5.615
-37	-3.706	-47	-4.712	-57	-5.716
-38	-3.807	-48	-4.810	-58	-5.817
-39	-3.907	-49	-4.911	-59	-5.917
-40	-4.007	-50	-5.012	-60	-6.018
-41	-4.108	-51	-5.112	-61	-6.119
-42	-4.209	-52	-5.213	-62	-6.219
-43	-4.309	-53	-5.314	-63	-6.320
-44	-4.410	-54	-5.414		